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Federal Railroad Administration
Office of Policy

Double Stack Container Systems: Implications for U.S. Railroads and Ports

U.S. Department
of Transportation
Maritime Administration
Office of Port and
Intermodal Development

Executive Summary

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16. Abstract

This study assesses the potential for domestic double-stack container transportation and the implications of expanded double-stack systems for railroads, ports, and ocean carriers. The study suggests that double-stack service can be fully competitive with trucks in dense traffic corridors of 725 miles or more. There are opportunities to substantially increase double-stack service in existing corridors and to introduce double-stack service in secondary corridors, in outlying areas near major hubs, and for refrigerated commodities. To meet the challenge of providing and marketing a reliable, high quality, door-to-door service, railroads may have to take unaccustomed steps into marketing and customer service, or become strictly line-haul carriers. Ports must accommodate international double-stack growth, but they will be only indirectly affected by domestic containerization. Intermodal affiliates of ocean carriers will retain their leadership role in domestic containerization, while the ocean carriers themselves concentrate on international movements and markets.

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DOUBLE-STACK CONTAINER SYSTEMS:
IMPLICATIONS FOR U.S. RAILROADS AND PORTS

ABSTRACT

Double-stack container systems have grown rapidly since their introduction as an inland extension of international service, and are on the verge of large-scale domestic containerization. This Federal Railroad Administration/ Maritime Administration study was performed by Manalytics, Inc., and subcontractors ALK Associates, Transportation Research and Marketing, and TF Transportation Consultants. The study describes double-stack systems, determines their potential for domestic container transportation, and identifies their implications for railroads, ports, and ocean carriers.

As of 1989, double-stack container service was available in some form on most major rail routes, and most major hub cities. The fleet of double-stack cars has increased rapidly, and now accounts for about 25 percent of total intermodal capacity.

Cost and service criteria were derived to determine where double-stacks could compete with trucks. Double-stack cost advantages are in the line-haul. Cost-competitive double-stack hauls must be long enough for line-haul savings to outweigh terminal and drayage costs, which trucks do not incur, and still offer the lower rates that customers expect. Using an engineered cost methodology and favorable assumptions, the study found that double-stack services could compete with trucks on movements of 725 miles or more, with drayage of up to 30 miles on each end. To offer competitive transit times, double-stacks must have a long enough haul to overcome a terminal and drayage handicap of six hours or more. Comparing truck and double-stack trip profiles suggests that the haul must be at least 540 miles, so the 725-mile cost criterion is the binding constraint. To offer competitive service frequency, the double-stack route must have enough volume for six-day-per-week service at major hubs, and five-day-per-week service at intermediate points.

The study applies these criteria to 1987 rail and truck data to identify a core network of truck-competitive double-stack routes, and truck flows

that could potentially be diverted. The core network includes much of the existing intermodal traffic, but some significant flows would remain in trailers or convert to double-stack for other reasons. The study also applied growth factors to estimate potential year 2000 flows.

The hypothetical 1987 double-stack network would include about 5.9 million container movements, of which 1.2 million were already in containers, 1.1 million were in trailers, 0.4 million were in boxcars, and 3.2 million were in trucks. About 264,000 new domestic containers, 132,000 chassis, and 5,300 double-stack cars would be needed. Most intermodal terminals have adequate capacity, but some investment would be required for expansion of smaller facilities. There will also be a significant cost for improved clearances on some routes. The railroads may incur only part of this capital cost: most equipment is supplied by Trailer Train, ocean carrier affiliates, or leasing companies, and some nonrail participants have financed terminals or clearance improvements.

For domestic double-stack services to prosper in competition with trucks, railroads may have to take unaccustomed steps into marketing and customer service, or become strictly line-haul carriers and rely on others for the remaining service functions. For ports and ocean carriers, the implications are mixed. Ports must accommodate international double-stack growth, but will be only indirectly affected by domestic containerization. The North American intermodal affiliates of ocean carriers will retain their leadership role in domestic containerization, while the ocean carriers themselves concentrate on international movements and markets.

The advent of double-stack container systems has dramatically altered intermodal transportation. New firms have entered, existing firms have new roles, and new alliances have formed. A distinct intermodal industry is emerging. To realize the full potential of domestic double-stack container systems, requires that the intermodal industry must face several challenges that can be summed up as one: provide and market a reliable, high-quality, door-to-door service. If the intermodal industry can do so, double-stack container systems can compete successfully with trucks and sustain a much larger traffic volume and market share than intermodal transportation has yet achieved.

Table of Contents

Table of Contents
(Continued)

Table of Tables

Table of Figures

I. BACKGROUND AND PURPOSE

A. Background

Rapid growth in double-stack container operations has brought the intermodal industry to the verge of large-scale domestic containerization. The capacity of the double-stack fleet has increased from 400 container spaces in 1983 to an estimated 30,000 in 1989, while conventional trailer slots dropped by over 20,000. In that same period, rail transfer facilities have been condensed from over 400 ramps into a system of about 215 high-volume mechanized hubs capable of supporting frequent double-stack service in most major rail corridors. The necessary infrastructure for a domestic container system, seemingly unattainable just a decade ago, is largely in place.

Market forces are already in motion to create large-scale domestic double-stack container services in some markets. Domestic container services are routinely marketed by railroads, ocean carrier affiliates, and third parties. Yet the wholesale replacement of other intermodal services with double-stacked containers is not a certainty. There are operational, economic, and institutional issues to be resolved. The issue is not whether there will be domestic containerization: it is here. Rather, the issue is whether there will be an identifiable domestic double-stack network. The answer is "Yes": the forces are already in motion. The new questions are: Under what circumstances? Where? How large? And how do we get there from here?

Several factors came together to promote what has been called the "double-stack revolution":

- regulatory exemption of intermodal rail transportation, and the increased use of railroad contracts;

- facilitation of through intermodal bills of lading in the Shipping Act of 1984;

- rapid growth of containerized imports; and

- o the availability of double-stack technology as the most efficient means of carrying large numbers of containers inland.

These factors led to a rapid increase in the volume of international containers moving inland on double-stack trains under contracts between railroads and ocean carriers or their affiliates. The ocean carriers took the initiative at the beginning of this trend, guaranteeing annual traffic volumes and providing cars to minimize risk to the railroads. As the potential of double-stack traffic became more apparent, railroads hastened to offer contracts, supply equipment (through Trailer Train), and operate "common-user" trains to attract more ocean carriers. By 1989, the railroad/ocean carrier relationship had become a series of individual relationships ranging from simple rate structures covering volume "tiers" to large-scale assumption of railroad intermodal marketing functions by an ocean carrier affiliates.

Ports are involved in double-stack traffic largely as providers of facilities, but they have had, and will likely continue to have, other roles as well. In the initial period of double-stack activity, ports took an active role in promoting double-stack service for their ocean-carrier clients. This activity did not extend to operating "port trains," although some serious proposals were made. Some ports remain active as shipper's agents. The most active port role is the provision of on-dock facilities, where containers can be transferred between double-stack trains and the marine terminal without drayage over city streets.

The volume of domestic container traffic is small, but growing. The 1977 Census of Transportation found little rail or intermodal presence in hauls of less than 500 miles, which accounted for 83 percent of the intercity truck traffic. According to recent data compiled by the AAR, intermodal rail service accounts for 15-16 percent of the domestic traffic moving over 500 miles (excluding private trucking and team drivers), and domestic container traffic is now estimated to be about 9 percent of the intermodal total. Yet, intermodal service now accounts for up to 70 percent of those markets in which it is most successful (i.e., dry van truckload traffic between major cities more than 700 miles apart), and domestic double-stack container systems account for much of its recent success.

B. Purpose of This Study

This study was undertaken by the Federal Railroad Administration and the Maritime Administration to assemble a comprehensive picture of double-stack systems, to determine the potential for domestic double-stack container transportation, and to identify the implications of expanded double-stack systems for railroads, ports, and ocean carriers. The study was performed by Manalytics, Inc. and subcontractors ALK Associates, Transportation Research and Marketing, and TF Transportation Consultants. It answers six major questions:

- What is the status of double-stack container systems?
- Under what conditions can domestic double-stack container systems be competitive with trucks?
- What form might a potential double-stack network take?
- What implications would such a network have for railroads?
- What implications would such a network have for ports and ocean carriers?
- Are existing market forces sufficient to bring about an efficient double-stack network?

C. Study Approach

From the beginning, the study team recognized the critical importance of industry contacts to the successful completion of this study. In addition to the ad hoc contacts made during data acquisition and analysis, the study team assembled an Advisory Committee to review draft reports, suggest improvements, and maintain a realistic viewpoint. The following individuals served on the Advisory Committee and gave generously of their time and expertise:

Donald Cole
Vice President,
Planning & Development
Trailer Train Company

David J. DeBoer
Vice President,
Greenbrier Intermodal

Henry T. Domery
General Manager-Intermodal,
Pennsylvania Truck Lines

James H. McJunkin
Vice President,
American Association of Port Authorities

Steven C. Nieman
Vice President,
Strategic Planning
American President Domestic

Craig F. Rockey
Assistant Vice President,
Economics
Association of American Railroads

Phillip C. Yeager
Chairman,
The Hub Group, Inc.

The advice and participation of these individuals improved the quality and relevance of the study. The findings of this study, however, do not represent the positions or policies of these individuals or their organizations, and they bear no responsibility for study content.

The first task of this study was to establish the status quo for double-stack container systems. The study team drew traffic data from three major sources: the 1987 Carload Waybill Sample (CWS); the 1985-87 National Motor Transport Data Base (NMTDB); and the 1987 Bureau of the Census foreign trade database. Information on current double-stack operations and technology was obtained from industry contacts and publications.

The study team developed service and cost criteria to determine the conditions under which domestic double-stack container services could be fully competitive with truckload carriers, who constitute the major long-term competition. Service criteria were based on typical drayage, terminal, and transit times. Cost criteria were based on engineered cost estimates for each function in door-to-door double-stack service. Favorable assumptions were used to gauge the full potential of domestic double-stack container systems. The service and cost criteria, translated into volume and length of haul requirements, were applied to the relevant traffic data to generate a hypothetical 1987 core network of truck-competitive double-stack service. A methodology was developed to identify potentially divertible truck movements. Published growth forecasts for domestic and international intermodal traffic were then used to develop a hypothetical year 2000 core network.

Implications for railroads were identified in several areas: overall traffic volume; equipment and capital needs; terminal capacity; marketing; and changing roles within the intermodal field. Implications for ports and ocean carriers were likewise identified, focussing on the compatibility of international and domestic container flows; the impacts on port and ocean carrier operations; effects on port/ocean carrier/railroad relationships; and the future roles of ports and ocean carriers.

Statistics and cost estimates are only part of the story: the intermodal field has transcended the traditional roles of railroads, ports, and ocean carriers. The study team therefore examined the broader implications of domestic containerization for the emerging intermodal industry and the ways in which the participants do business.

II. THE STATUS OF DOUBLE-STACK CONTAINER SYSTEMS

Double-stack container systems have developed rapidly since their introduction. This report summarizes their status as of late 1989. The details of fleets, services, and markets change rapidly, but their fundamental characteristics are well established.

A. Intermodal Rail Technology

Table 1 shows the changing composition of the railroad intermodal fleet. Table 2 compares the specifications of major types.

Double-Stack Cars. Double-stack cars use a depressed well or platform to stack containers two-high within most railroad clearance limits. These wells or platforms are articulated in sets of five, adjacent wells being supported by one shared rail truck assembly. Double-stack cars are lighter, shorter, and more aerodynamic, and give a better ride, than other rail container cars. Double-stack cars provide the best net-to-tare ratio, and carry the greatest number of revenue loads for a given train length. These two factors correspond to the two major line-haul cost advantages of double-stack cars over other intermodal technologies: lower fuel consumption (due to lower weight) and lower labor costs (due to more revenue units per train crew). The articulation of double-stack cars, which they share with other recent types, greatly improves ride quality and reduces freight damage compared to conventional flatcars. The length and weight capacity of double-stack cars has been increased to handle 48-foot containers and heavier loads. The most recent version is the "Type 3" car, capable of handling 48-foot containers in all wells and equipped with 125-ton trucks to handle up to 125,000 pounds in each well. In 1989, there were approximately 3,200 five-unit double-stack cars in service, or 16,000 total wells.

Spine Cars. On corridors with restricted clearances or with insufficient traffic for double-stack service, some railroads are using spine cars, lightweight articulated cars that can carry one container on each of five units.

Table 1

INTERMODAL FLEET

	Total Spaces*	Conventional Cars	Third Generation Cars: Trailer Cars	Double-Stacks	Road-Railers
1983	110,000	109,000	200	400	300
1984	112,000	109,000	700	2,000	300
1985	119,000	109,000	2,900	7,000	300
1986	118,000	102,000	3,100	13,000	300
1987	116,000	93,000	4,800	18,000	1,400
1988	118,000	88,000	5,800	24,000	2,300
1989	120,000	79,000	9,000	30,000	2,300

* Units are trailer or container spaces or slots.

Source : Greenbrier Intermodal

Table 2

WEIGHT CAPACITY COMPARISONS

Car Type	Net Weight Capacity (lbs.)	Total Tare Weight (lbs.)	Coupled Length (ft.)	Net/ Tare	Net Lbs. Per Foot
Standard TOFC, 2 45-Foot Vans	104,000	93,600	93-8	1.11	1,110
Front Runner 48-Foot Van	50,000	40,000	53-10	1.25	929
Impack 5 45-Foot Vans	260,000	190,000	263-2	1.37	988
Standard COFC	116,000	83,800	94-8	1.38	1,225
Spine Car 5 48-Foot Containers	295,500	195,000	251-8	1.52	1,174
Double-Stack IBC 5 45-Foot Containers 5 48-Foot Containers	526,800	267,250	289-8	1.97	1,819
Boxcar 70-Ton, 50'6"	154,000	66,000	55-7	2.33	2,775
RoadRailer Mark V	48,800	16,200	48-0	2.01	1,017

Source: Manufacturers and Industry Publications

The light weight and articulation of spine cars yield some of the same line-haul cost savings as double-stack cars.

Conventional and Lightweight Trailer Cars. Trailer traffic is split between conventional flatcars (mostly 90 feet long with full decks and two hitches), skeleton cars (articulated cars similar to spine cars), and lightweight single-trailer cars (Trailer Train's Frontrunner). There are also some rebuilt flatcars, modified boxcars, and some all-purpose spine cars in TOFC service. Recent purchases have been articulated skeleton cars or all-purpose spine cars, which are considered third-generation cars.

RoadRailers. There is a small but growing number of "carless" trailers that can travel either on rail or highway. Those in service are known as "RoadRailers," although there have been proposals and prototypes from other builders. Thus far, RoadRailers have been used only in dedicated trains, and only on relatively short hauls. A container-carrying prototype has been built, but has not been placed in regular service.

B. Relevant Rail Traffic

Relevant rail traffic is composed of three categories:

- o container traffic, on double-stack cars, on flatcars (COFC), or on chassis (TOFC);
- o trailer traffic (TOFC); and
- o selected containerizable boxcar traffic.

RoadRailer traffic is still small compared to the above categories, and much of its present growth has occurred since the study base year of 1987. RoadRailer traffic is therefore not included in this analysis.

Data on relevant container traffic were drawn from the 1987 Carload Waybill Sample (CWS). It was determined that the CWS data could be used to distinguish containers from trailers accurately, but could not be used to reliably distinguish existing double-stack movements from COFC or TOFC container movements (or to distinguish loaded from empty containers or trailers). 1987 rail container movement patterns are shown in Figure 1. The data do not permit segregation of container movements by size (i.e., 20-foot vs. 40-foot vs. 48-foot containers). With the knowledge that the vast majority of containers moving by rail are 40 feet long or longer, the small number of 20-foot containers were not treated separately.

It is apparent from Figure 1 that rail container flows are heavily concentrated in a few major traffic lanes connecting major container ports with major inland intermodal hubs. Existing (1987) container traffic is overwhelmingly international. CWS data do not distinguish between international and domestic container movements, but there is widespread agreement that domestic container movements are still a small part of the total. According to an estimate by Trailer Train, domestic container movements accounted for about 5-7 percent of all rail intermodal traffic in 1988, and about 9 percent in 1989.

Figure 2 shows comparable data for rail trailer traffic, also drawn from the CWS. All trailer traffic was considered containerizable on a one-for-one basis, although there are a very few exceptions.

Boxcar data were likewise drawn from the 1987 CWS. Most boxcar commodities are potentially containerizable; only a few commodities, such as grain were excluded. The small amount of traffic that moved in refrigerated boxcars was included. Boxcars are larger and can carry more weight than containers, so the boxcar data were converted to "container equivalents". Density factors from Manalytics' proprietary international trade database were used to convert boxcar tonnage into the equivalent volumes of 48-foot-long, 102-inch-wide, 9-foot-6-inch-high domestic containers shown in Figure 3. While many of the major boxcar flows use the same corridors as the container and trailer flows, there are a number of major boxcar origins, such as Eugene, Oregon, that do not have comparable container or trailer flows.

Figure 4 illustrates the total 1987 relevant rail traffic, including container, trailer, and selected boxcar traffic.

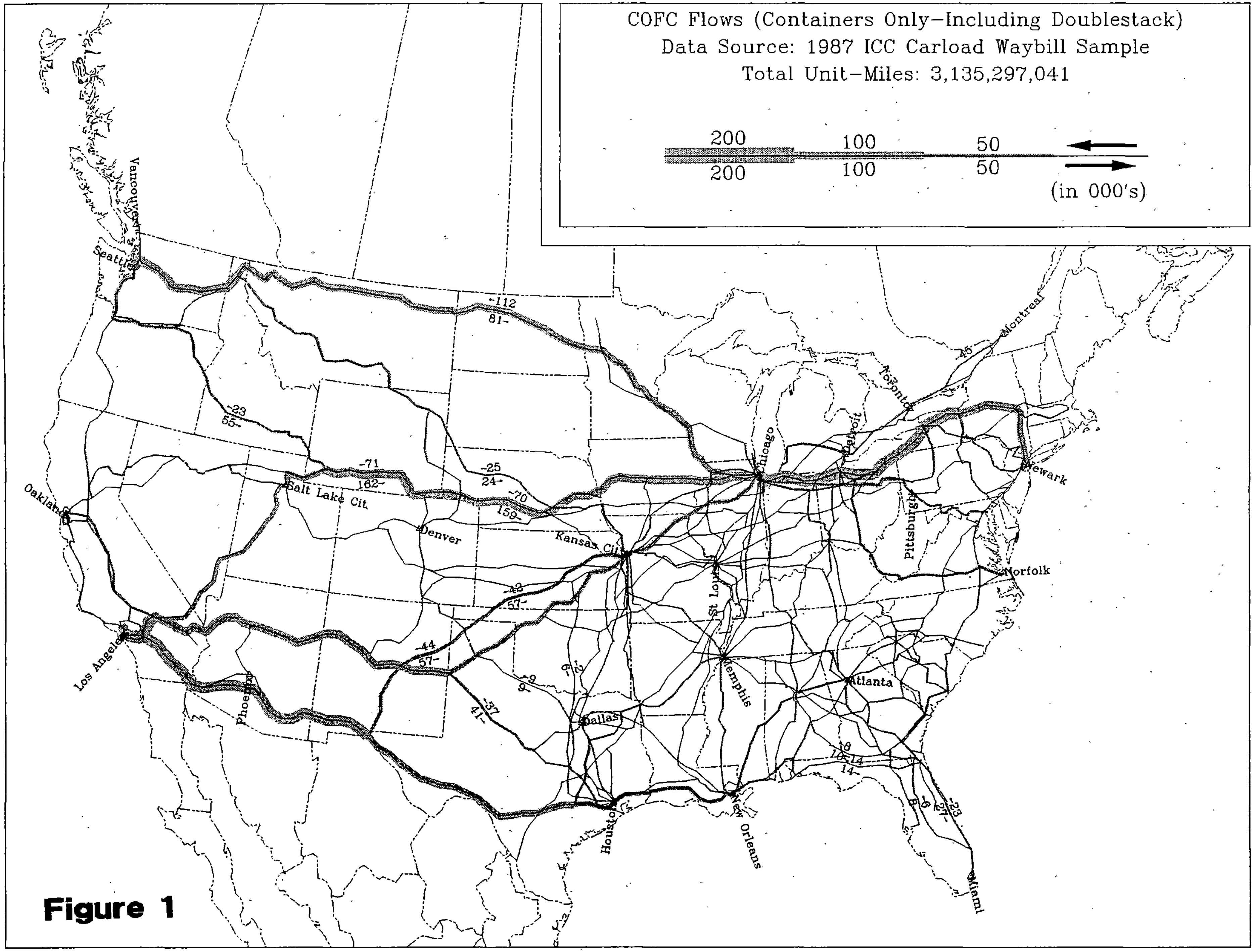
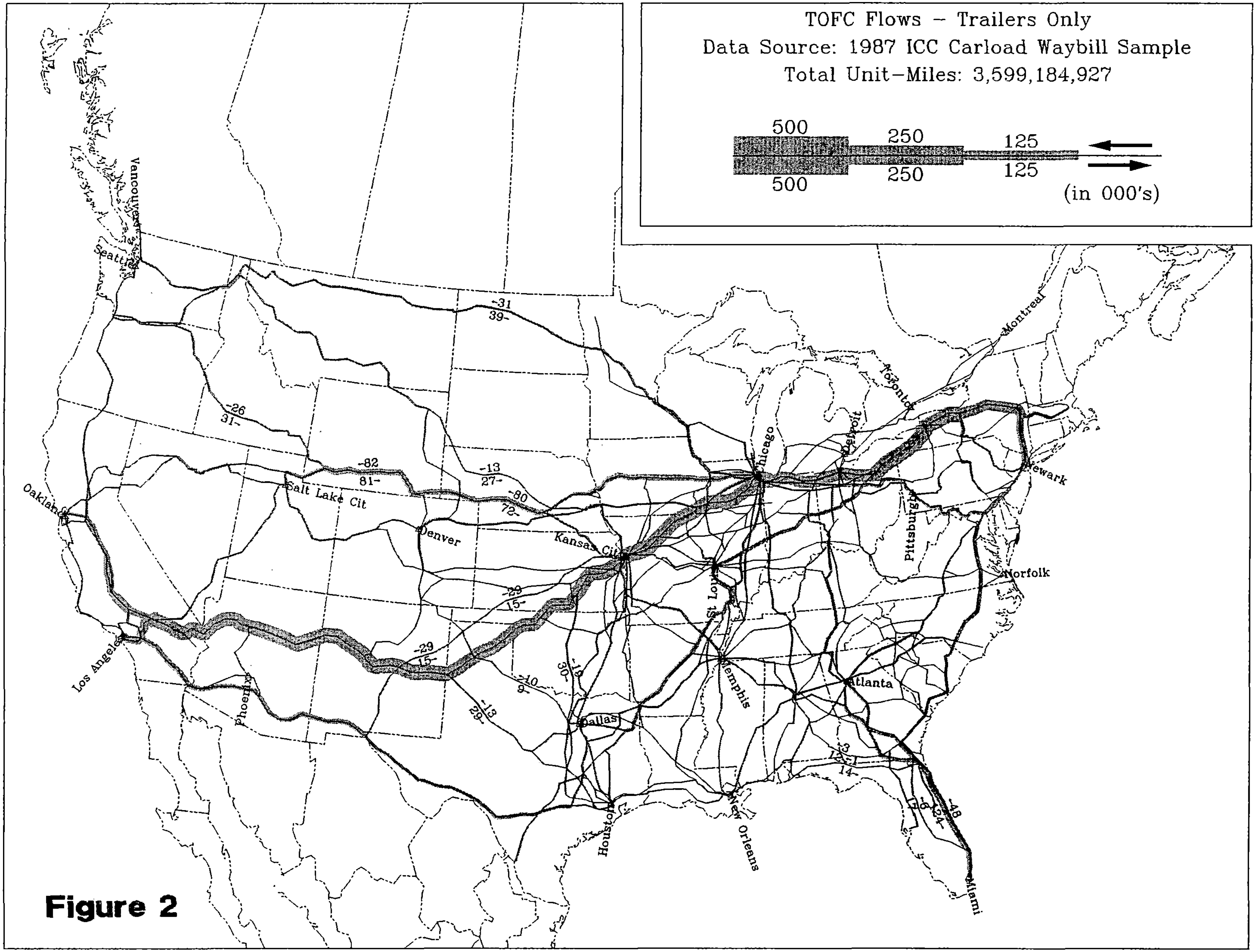
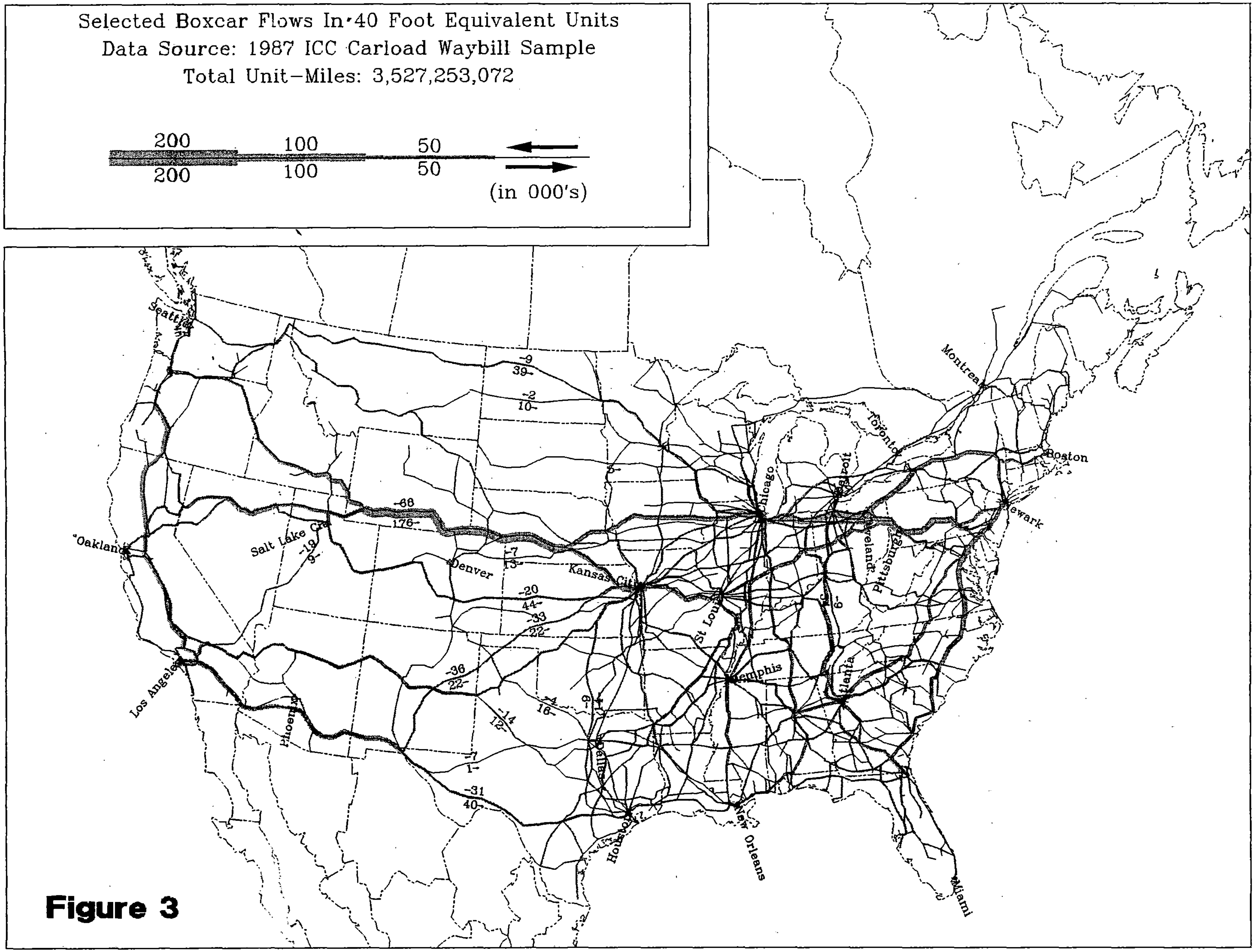

COFC Flows (Containers Only–Including Doublestack)
Data Source: 1987 ICC Carload Waybill Sample
Total Unit–Miles: 3,135,297,041
200
200
100
100
50
50
(in 000's)
Vancouver
Seattle
Oakland
Los Angeles
Phoenix
Salt Lake Cit
Denver
Kansas Cit
Dallas
Houston
New Orleans
Memphis
St Louis
Chicago
Detroit
Toronto
Montreal
Pittsburgh
Newark
Norfolk
Atlanta
Miami
112
81
23
55
71
162
25
24
70
159
42
57
44
57
37
41
9
9
45
23
27
14
14
16

Figure 1



TOFC Flows – Trailers Only
Data Source: 1987 ICC Carload Waybill Sample
Total Unit–Miles: 3,599,184,927
500
250
125
500
250
125
(in 000's)
Vancouver
Seattle
Oakland
Los Angeles
Phoenix
Salt Lake Cit
Denver
Kansas Cit
Dallas
Houston
Chicago
St Lo
Memphis
New Orleans
Atlanta
Detroit
Toronto
Montreal
Pittsburgh
Newark
Norfolk
Miami

Figure 2



Selected Boxcar Flows In 40 Foot Equivalent Units
Data Source: 1987 ICC Carload Waybill Sample
Total Unit-Miles: 3,527,253,072
200
100
50
200
100
50
(in 000's)
Seattle
Oakland
Salt Lake City
Los Angeles
Phoenix
Denver
Kansas City
St Louis
Chicago
Detroit
Toronto
Montreal
Boston
Newark
Cleveland
Pittsburgh
Memphis
Atlanta
Dallas
Houston
New Orleans
Miami
-9
39-
-2
10-
-68
176-
-19
9-
-7
13-
-20
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22-
-4
16-
-14
12-
-7
1-
-31
40-

Figure 3

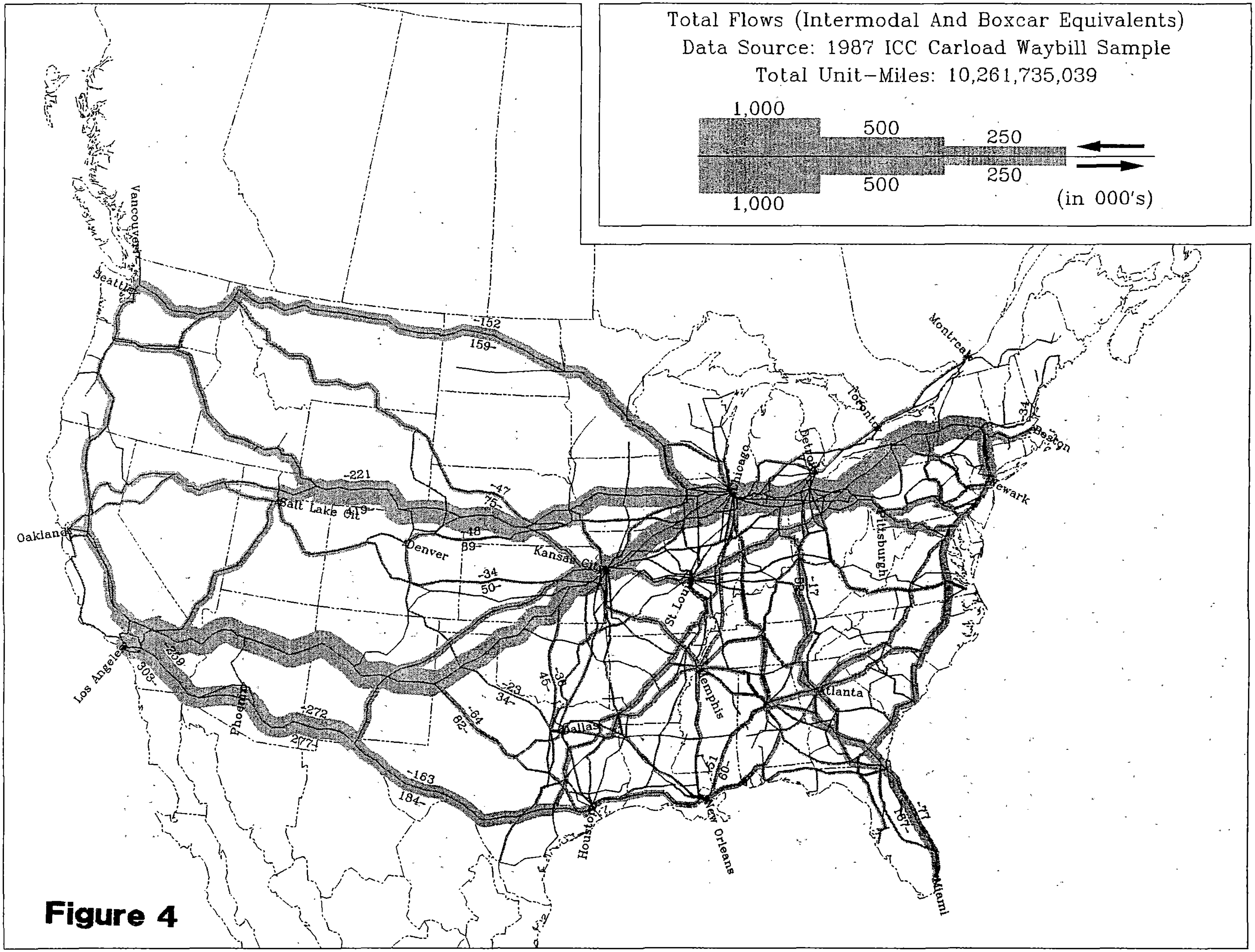

Total Flows (Intermodal And Boxcar Equivalents)
Data Source: 1987 ICC Carload Waybill Sample
Total Unit-Miles: 10,261,735,039
1,000
500
250
250
500
1,000
(in 000's)
Vancouver
Seattle
Oakland
Los Angeles
Salt Lake City
Denver
Phoenix
Kansas City
Dallas
Houston
New Orleans
St Louis
Memphis
Chicago
Detroit
Toronto
Montreal
Boston
Newark
Pittsburgh
Atlanta
Miami

Figure 4

C. Relevant Truck Traffic

Data on relevant truck traffic were drawn from the National Motor Transport Database (NMTDB). Dry and refrigerated truckload traffic were included; less-than-truckload and specialized truck traffic (tank, household goods, etc.) were excluded. The NMTDB data are collected at some 19 passing-count and interview sites. For this study, four sites were determined to be relevant: Eloy, AZ; Gallup, NM; Rock Springs, WY; and Redding, CA (Figure 5). These sites yield data on long-distance truck traffic via Interstates 5, 10, 40, and 80, thereby covering the majority of truck traffic for which double-stack trains compete. Data were not initially compiled for shorter, inter-regional and intra-regional flows where double-stacks were not competing in 1987, and later analysis proved this distinction to be generally valid. The data were summarized according to the regions shown in Figure 5. Figure 6 distributes the identifiable relevant truck traffic on the rail network, using the shortest rail route for each flow. Figure 7 shows both the relevant rail traffic and the relevant truck traffic for comparison. Truckload dry and refrigerated traffic was considered containerizable on a one-for-one basis.

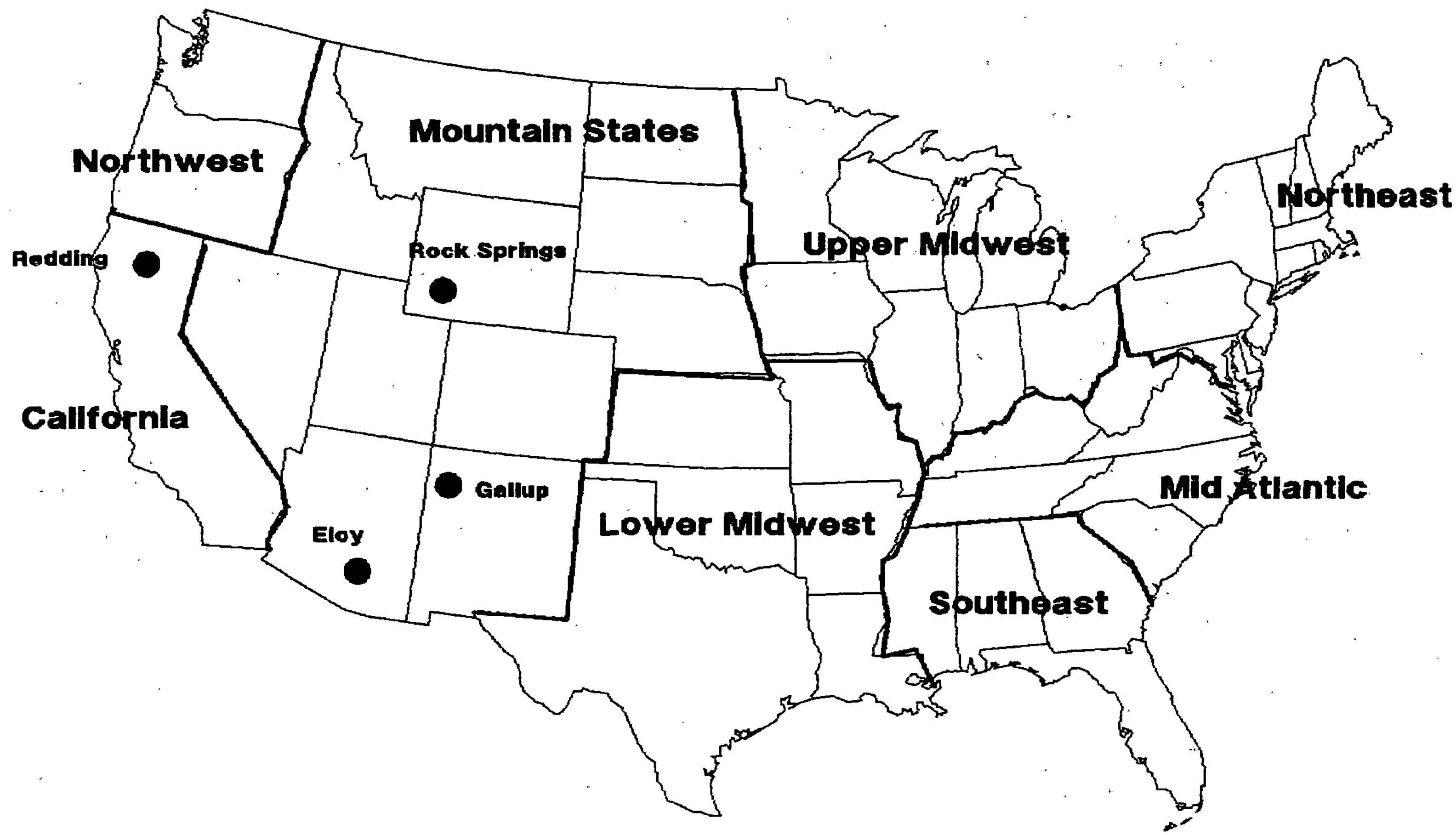
D. International Container Traffic

Data on 1987 inland flows of international container traffic (not including transloaded containers) were taken from information compiled by the Bureau of the Census. All data were converted to forty-foot equivalent units (FEU), and aggregated in the same regions as those used for the truck data. In analyzing the data it was found that records accounting for 22 percent of the total tonnage did not have complete inland geographic detail. Incomplete records were allocated among inland regions in the proportions established by complete records. Table 3 lists the major flows by coast.

E. Rail Intermodal Facilities

Most existing intermodal facilities have mechanical lift equipment capable of handling double-stacked containers. Hubs with current double-stack service are shown in Figure 8.

Figure 5
Multi-State Inland Regions
And Truck Data Collection Sites



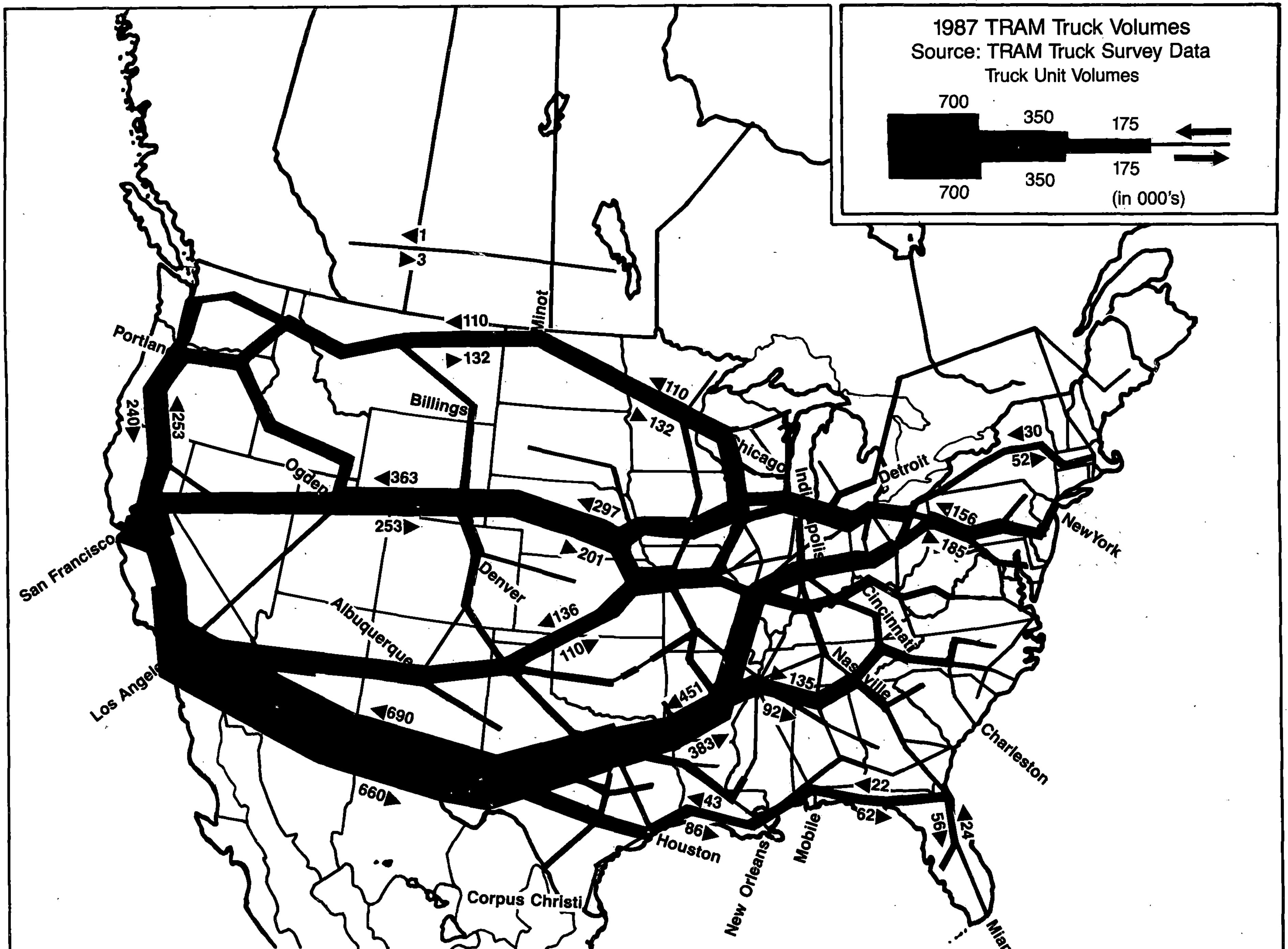
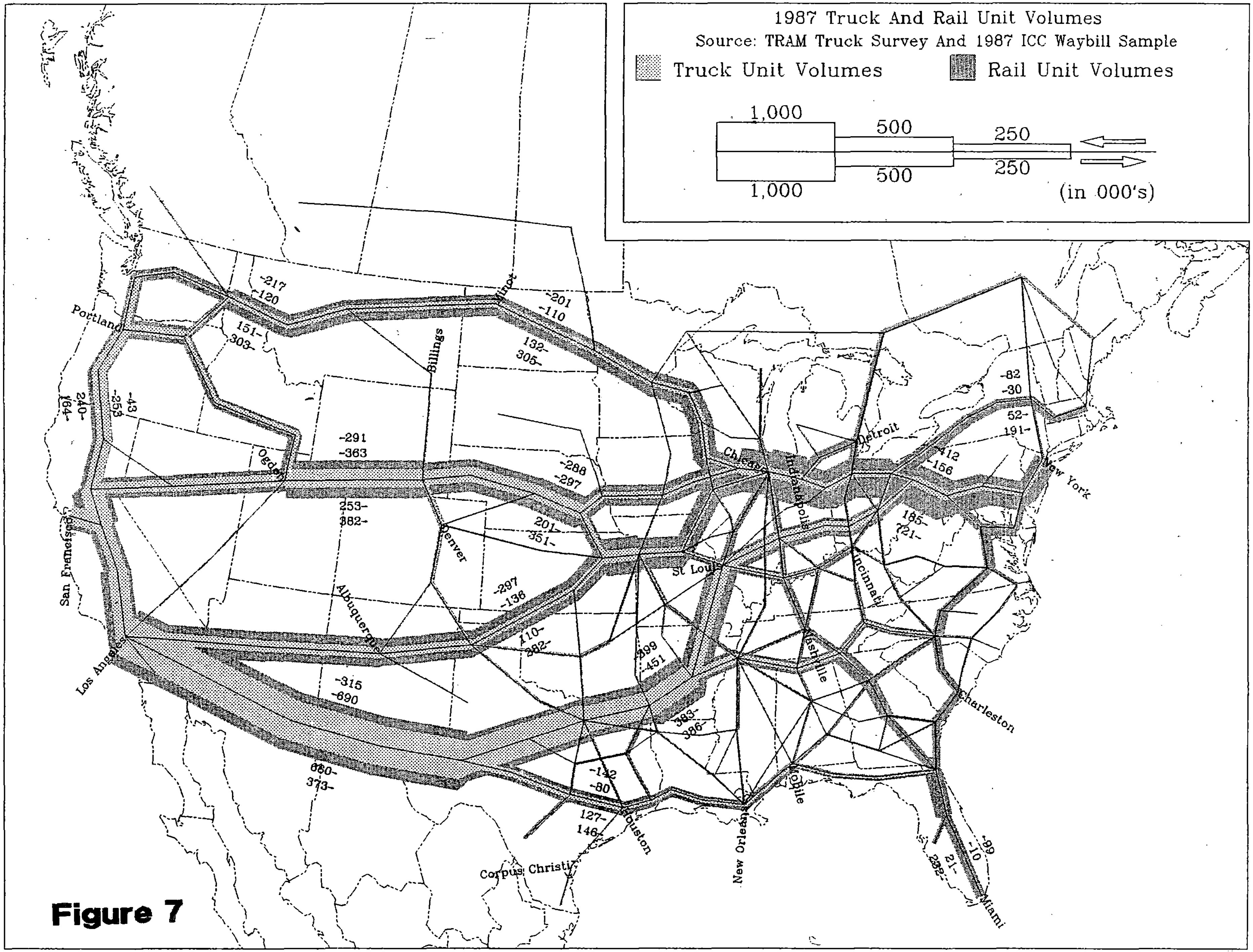

1987 TRAM Truck Volumes
Source: TRAM Truck Survey Data
Truck Unit Volumes
700
350
175
175
700
350
(in 000's)
1
3
110
132
Minot
Portland
240
253
Billings
110
132
Chicago
Detroit
30
52
Ogden
363
297
Indianapolis
156
New York
253
201
185
San Francisco
Denver
Cincinnati
Albuquerque
136
110
Nashville
Los Angeles
451
135
690
92
383
Charleston
22
660
43
62
86
56
24
Houston
New Orleans
Mobile
Corpus Christi
Miami

Figure 6



1987 Truck And Rail Unit Volumes
Source: TRAM Truck Survey And 1987 ICC Waybill Sample
Truck Unit Volumes
Rail Unit Volumes
1,000
500
250
250
500
1,000
(in 000's)
Portland
San Francisco
Los Angeles
Ogden
Billings
Minot
Denver
Albuquerque
Chicago
Indianapolis
Detroit
New York
St Louis
Cincinnati
Nashville
Charleston
Mobile
New Orleans
Houston
Corpus Christi
Miami
-217
-120
151-
303-
-201
-110
132-
305-
-291
-363
-288
-297
253-
382-
201-
351-
-297
-136
110-
382-
-315
-690
660-
373-
399
451
383-
386-
-142
-80
127-
146-
-82
-30
52-
191-
-112
-156
185-
721-
-99
-10
21-
232-
240-
164-
-43
-253

Figure 7

Table 3

1987 IMPORT/EXPORT SUMMARY
By Inland Region and Coast

	Import FEUs	Weekly Train Equivalents	Export FEUs	Weekly Train Equivalents
** California				
Atlantic	37929	3.8	2657	0.3
Great Lakes	10	0.0	18	0.0
Gulf	6741	0.7	6190	0.6
Pacific	328976	32.9	161752	16.2
** Subtotal **	373656	37.4	170617	17.1
** Lower Midwest				
Atlantic	17836	1.8	7729	0.8
Great Lakes	69	0.0	150	0.0
Gulf	23824	2.4	92649	9.3
Pacific	67382	6.7	53192	5.3
** Subtotal **	109111	10.9	153720	15.4
** Mid Atlantic				
Atlantic	81992	8.2	115575	11.6
Great Lakes	29	0.0	8	0.0
Gulf	2428	0.2	5607	0.6
Pacific	34143	3.4	14604	1.5
** Subtotal **	118592	11.9	135794	13.6
** Mountain				
Atlantic	4258	0.4	2284	0.2
Great Lakes	1	0.0	137	0.0
Gulf	2725	0.3	4904	0.5
Pacific	14975	1.5	21793	2.2
** Subtotal **	21959	2.2	29118	2.9

Source: Bureau of the Census

Table 3

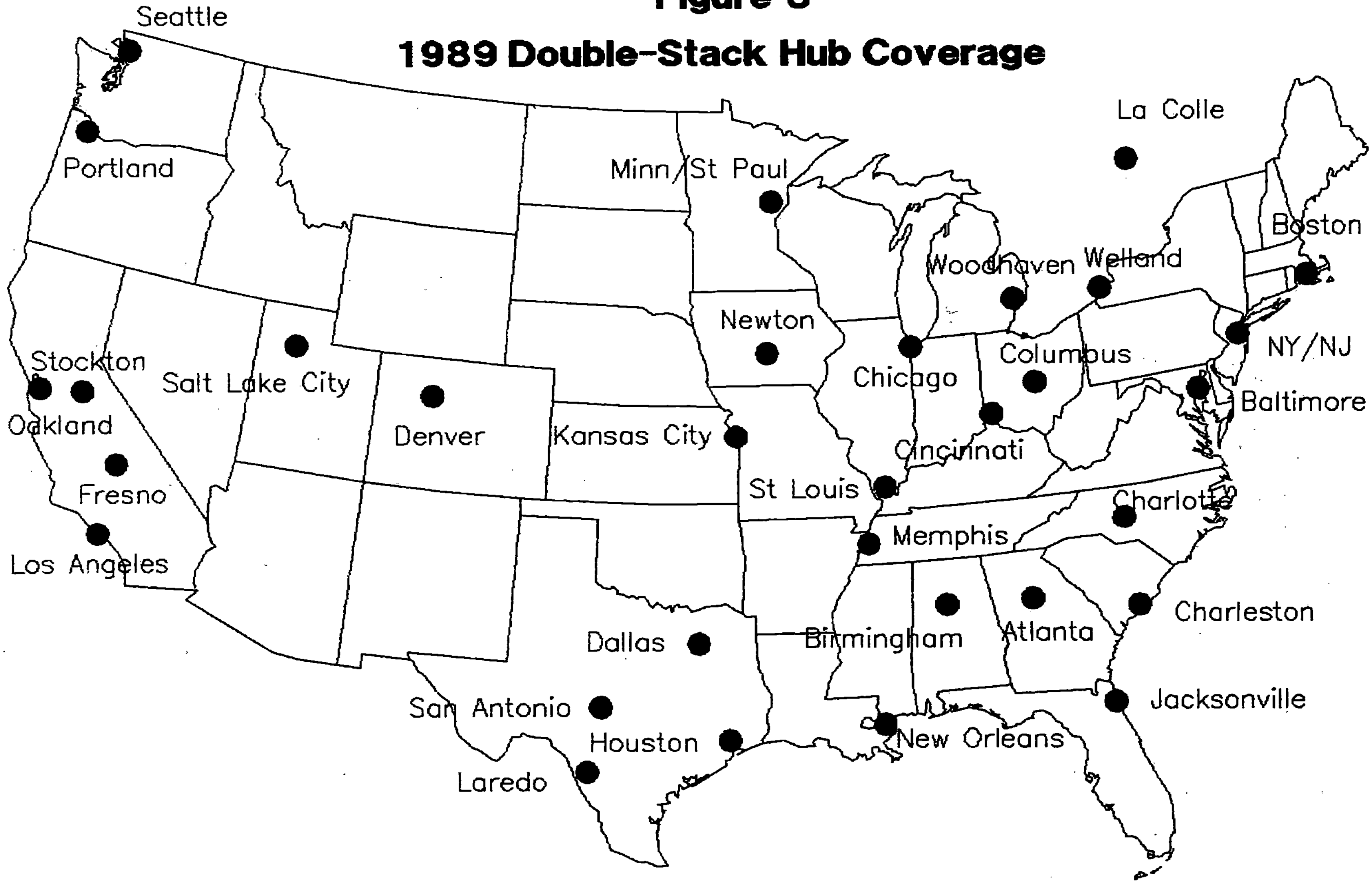
1987 IMPORT/EXPORT SUMMARY
By Inland Region and Coast

	Import FEUs	Weekly Train Equivalents	Export FEUs	Weekly Train Equivalents
** Northeast				
Atlantic	571910	57.2	86542	8.7
Great Lakes	275	0.0	26	0.0
Gulf	30969	3.1	4193	0.4
Pacific	294413	29.4	9936	1.0
** Subtotal **	897567	89.8	100697	10.1
** Northwest				
Atlantic	4994	0.5	1180	0.1
Great Lakes	4	0.0	35	0.0
Gulf	801	0.1	519	0.1
Pacific	34594	3.5	116182	11.6
** Subtotal **	40393	4.0	117916	11.8
** Southeast				
Atlantic	89750	9.0	103014	10.3
Great Lakes	17	0.0	17	0.0
Gulf	43133	4.3	44156	4.4
Pacific	24308	2.4	15564	1.6
** Subtotal **	157208	15.7	162751	16.3
** Upper Midwest				
Atlantic	87355	8.7	34095	3.4
Great Lakes	885	0.1	1735	0.2
Gulf	9815	1.0	4991	0.5
Pacific	153375	15.3	37972	3.8
** Subtotal **	251430	25.1	78793	7.9
*** Total ***	1969916	197.0	949406	94.9

Source: Bureau of the Census

Figure 8

1989 Double-Stack Hub Coverage

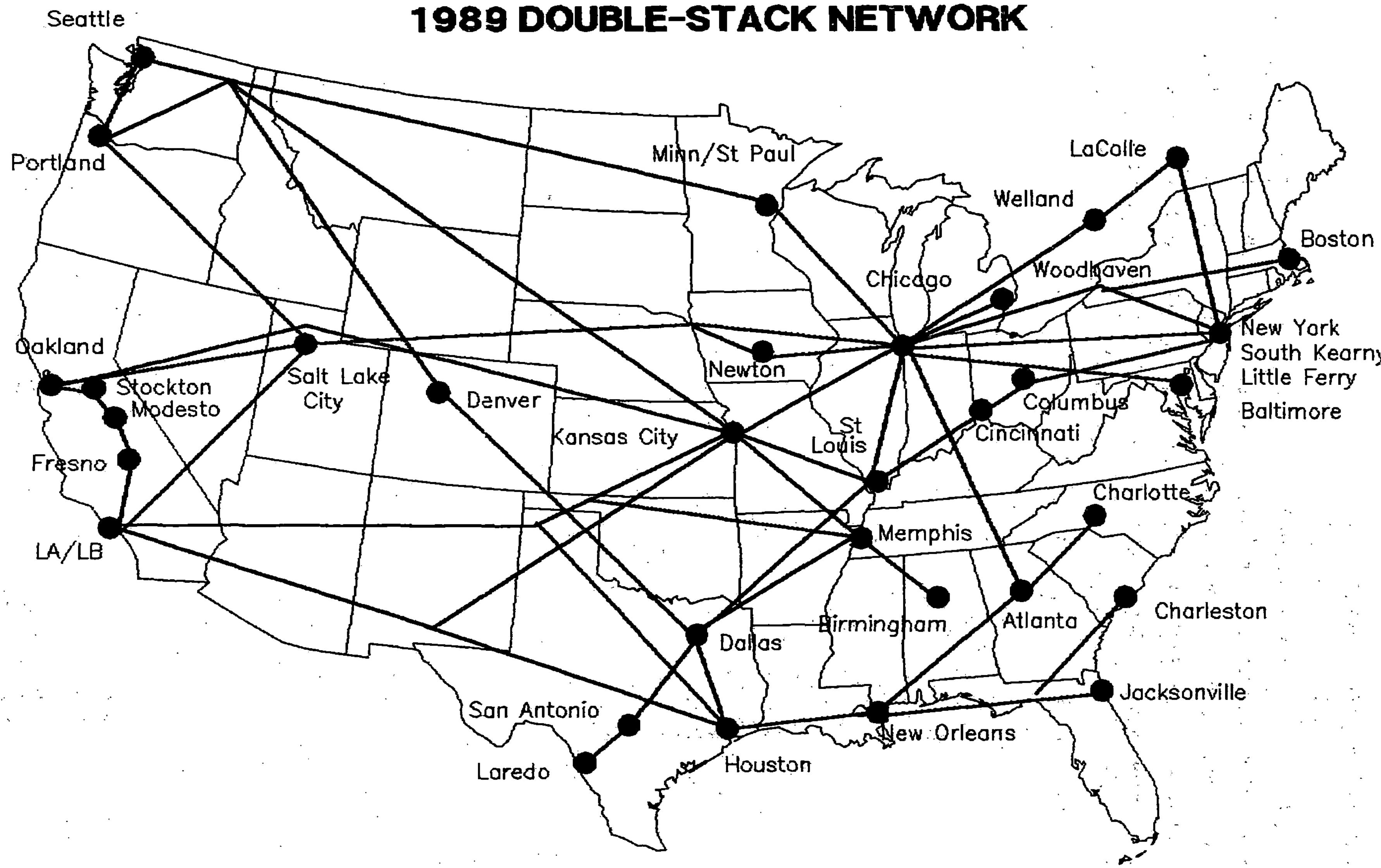


F. Current Double-Stack Services

As of mid-1989, there were a large number and variety of double-stack services. Over 100 trains depart the West Coast each week with double-stack traffic. Services included single-customer unit trains, regularly scheduled "common user" trains serving multiple customers, combined double-stack and conventional intermodal trains, and blocks of double-stack cars moving on intermodal or manifest freight trains. Figure 9 illustrates the network of double-stack services offered in late 1989.

Figure 9

1989 DOUBLE-STACK NETWORK



III. COMPETITIVE DOUBLE-STACK CONTAINER SERVICES

Double-stack container systems have line-haul cost advantages over other intermodal technologies, and may replace those technologies to a large extent. Unless double-stack service is fully competitive with truckload service, however, domestic double-stack traffic will remain subject to continual erosion by motor carrier competition. According to surveys, many customers do not yet consider double-stack service to be the equal of truckload service. For this reason, domestic double-stack services must offer similar door-to-door transit at lower door-to-door rates in order to be fully truck-competitive.

A. Cost and Service Advantages over Piggyback

Double-stack cars have a higher net-to-tare ratio than other intermodal cars, and therefore require less motive power and fuel to move the same amount of freight. Double-stack cars also have significant aerodynamic advantages over other intermodal types, further reducing fuel use. Double-stacking allows the railroads to carry more containers in a given train length, thereby reducing the operating labor cost per unit. Line-haul cost savings range from 20-40 percent relative to other intermodal technologies, depending on length of haul and other variables.

Articulation of double-stack cars yields a dramatic improvement in ride quality compared to non-articulated cars. Until the introduction of articulation, intermodal rail service typically caused greater freight damage than truckload service, thereby incurring the cost of blocking and bracing freight, processing and paying claims, and discouraging customers. With the use of articulated cars, railroads can now offer ride quality equal or superior to trucks.

Double-stack systems do not, however, offer significantly lower terminal or overhead costs than other intermodal systems. The cost of loading and unloading double-stacked containers is comparable to the cost of loading and unloading trailers or containers from other equipment types. The use of a chassis on each end of the trip imposes an additional cost on container systems that is not born by trailer systems. Trailer and container systems incur identical drayage costs between the shipper and the originating rail hub, and between the terminating rail hub and the consignee.

Table 4 summarizes the cost elements of simulated double-stack movements between Los Angeles and New Orleans, a distance of 2010 miles, and Los Angeles and Oakland, a distance of 559 miles. Line-haul costs were simulated using the Manalytics Rail Cost Model, and other costs were estimated from industry averages. Favorable assumptions were used throughout (ie, three-person train crews and no empty mileage) to determine the attainable potential performance of double-stack systems. As shown in Table 4, total costs could be as low as $.336 per unit mile for the Los Angeles-New Orleans longhaul movement.

B. Cost and Service Competition with Trucks

Cost Criteria. Door-to-door domestic double-stack costs should be no more than roughly 85 percent of truckload costs, allowing a 15 percent margin for the discount currently expected by intermodal customers. The trip must therefore be long enough for the line-haul cost advantages of double-stacks to overcome the higher terminal costs. With terminal transfer and chassis costs remaining constant, the door-to-door cost of double-stack service depends on the length of line-haul, and on the time and distance required for drayage. Using favorable assumptions regarding rail operations and operating costs, and a drayage distance of up to 30 miles on each end, it was determined that the double-stack line-haul must be at least 725 miles to be competitive with the operating costs of truckload carriers (excluding overhead profit of both modes).

Service Criteria. There are numerous tangible and intangible aspects to service quality, of which two -- transit time and service frequency -- can be readily quantified.

Double-stack services are handicapped by the time required for drayage and terminal functions at both ends, a minimum combined total of approximately 6 hours. Although double-stack trains can attain speeds of 79 mph on good track, they average approximately 40 miles per hour (due to stops and crew

Table 4

TOTAL DOUBLE-STACK OPERATING COSTS
$/Unit-Mile

Route	Line Haul $/unit mile	Line Haul Cost	Line Haul Car Cost	Terminal Car Cost	Container Cost	Terminal Lift	Chassis Cost	Drayage	Total	Total $/unit mile
L.A.-New Orleans										
2010.2 Miles 48 Hours	0.124	249.26	27.03	3.49	32.50	68.00	16.00	280.00	676.28	0.336
L.A.-Oakland										
559.4 Miles 15 Hours	0.144	80.55	10.62	3.49	19.50	68.00	16.00	280.00	478.16	0.855

changes) on the line-haul. Truck drivers depart directly from origin at an average of 54 miles per hour, and can operate 10 hours before resting for 8 hours. The two operating patterns are illustrated in Figure 10. As Figure 10 shows, the minimum line-haul distance required for double-stack service to approach truckload transit times is about 540 miles. Because the cost criteria set a minimum distance of 725 miles, the 540-mile transit time threshold is not controlling.

In order to compete with motor carriers for domestic traffic, double-stack services must also offer frequent departures. Major domestic corridors will require six-day-per-week service to attract service-sensitive customers such as United Parcel Service, the U.S. Postal Service, and LTL motor carriers. Five-day-per-week service is considered adequate for originations and terminations at intermediate points with lower traffic volumes.

Minimum service frequencies imply minimum annual volumes if trains are to be of an efficient minimum size. Current industry practices, reinforced by an analysis of unit costs, suggest a minimum train length of 15 cars, carrying 150 containers. Six such trains per week yield a minimum annual volume of 46,800 containers. Intermediate points do not require full trains: a single car carrying 10 containers five days per week requires an annual volume of 2600 containers. Railroads are generally willing to initiate services at less than the long-term minimum, with expectations of growth. At a somewhat arbitrary start-up threshold of 60 percent, the minimum volumes for a competitive service frequency are 28,080 annual containers for trains on major corridors, and 1560 annual containers at intermediate points.

The need for long hauls and frequent service to compete with trucks is demonstrated by the record of truck diversion to date. Significant truck diversions have taken place in major double-stack corridors such as Seattle-Chicago and Chicago-Los Angeles, where hauls are in excess of 1500 miles and service frequency is daily or better.

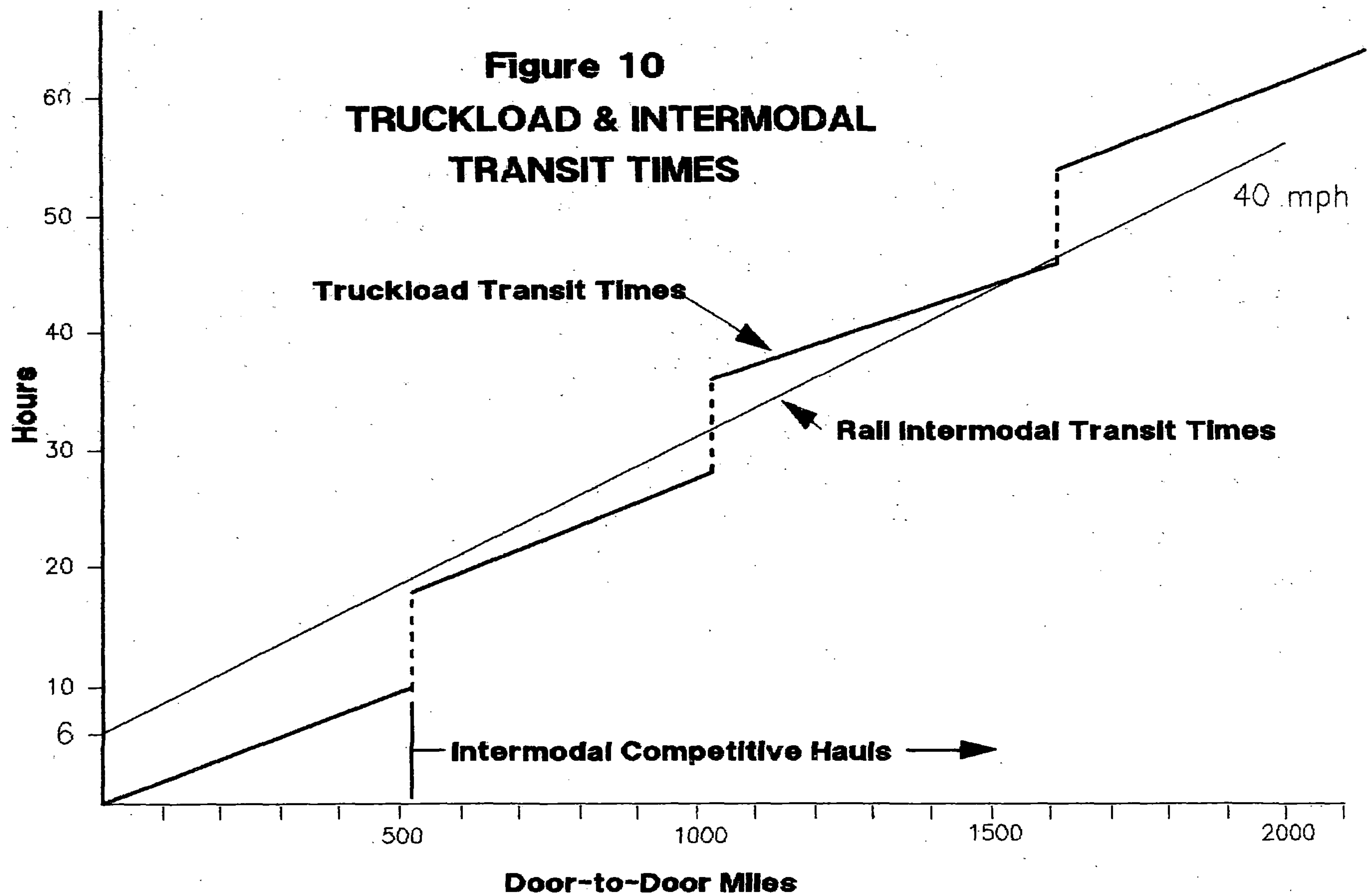


Figure 10
TRUCKLOAD & INTERMODAL
TRANSIT TIMES
Hours
60
50
40
30
20
10
6
40 mph
Truckload Transit Times
Rail Intermodal Transit Times
Intermodal Competitive Hauls
500
1000
1500
2000
Door-to-Door Miles

IV. POTENTIAL DOUBLE-STACK NETWORKS

A. 1987 Double-Stack Corridors

Using the cost and service criteria set forth above, those rail corridors that could have supported truck-competitive double-stack service in 1987 (the base year for this study) were identified from CWS data. For major corridors between BEA pairs, the minimum length of haul was 725 miles and the minimum threshold volume was 28,080 annual units of relevant rail traffic (containers, trailers, or selected boxcar traffic in container equivalents). The corridors thus identified are listed in Table 5, and illustrated in Figure 11.

Once service is established on major corridors, truck-competitive service can also be offered at intermediate points where loaded double-stack cars can be set out and picked up, as long as the resulting movements are at least 725 miles and annual volume is at least 1560 containers to start with (to satisfy the cost and service criteria). Figure 12 illustrates the combined volumes of major BEA pairs and intermediate point flows on the qualifying corridors. Figure 12, and all similar figures, allocate the potential traffic over the shortest rail routes rather than attempting to assign market share to any particular railroad. Figure 12 thus depicts a core network of fully truck-competitive double-stack services that could have been offered in 1987, based on combined potential domestic and international volumes of rail containers and trailers, and selected boxcar traffic.

The quality of the available rail and marine data makes precise distinctions between domestic and international traffic flows impossible. Using either the Carload Waybill Sample or the Bureau of the Census import and export data, only the most prominent corridors can be identified with any confidence. These corridors are largely the same for domestic and international traffic and form a subset of the densest corridors shown in Figure 12.

B. 1987 Diversions of Truck Traffic

The double-stack services shown in Figure 11 are, by the criteria developed

RAIL TRAFFIC MEETING ANNUAL VOLUME CRITERIA OF 60 PERCENT OF 46,800 ANNUAL FEUS IN 1987
AND AT LEAST 725 MILES OF RAIL DISTANCE
BY ORIGIN BEA AND DESTINATION BEA WITH RAIL-HIGHWAY CIRCUITY APPENDED
SORTED BY ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE

ORIGIN BEA NUMBER AND NAME		DESTINATION BEA NUMBER AND NAME		ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
180	LOS ANGELES, CA	83	CHICAGO, IL	187,054	2,668,915	2,199	2,040	1.08
83	CHICAGO, IL	180	LOS ANGELES, CA	160,377	2,281,766	2,199	2,040	1.08
83	CHICAGO, IL	12	NEW YORK, NY	159,045	2,565,063	904	815	1.11
12	NEW YORK, NY	83	CHICAGO, IL	144,595	1,017,056	904	815	1.11
171	SEATTLE, WA	83	CHICAGO, IL	113,753	1,733,130	2,166	2,080	1.04
83	CHICAGO, IL	171	SEATTLE, WA	103,159	917,272	2,166	2,080	1.04
83	CHICAGO, IL	18	PHILADELPHIA, PA	79,559	1,336,916	836	785	1.06
83	CHICAGO, IL	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	59,385	799,948	2,222	2,120	1.05
83	CHICAGO, IL	4	BOSTON, MA	56,220	943,472	1,006	992	1.01
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	83	CHICAGO, IL	53,234	918,886	2,222	2,120	1.05
83	CHICAGO, IL	19	BALTIMORE, MD	49,160	786,084	811	773	1.05
122	HOUSTON, TX	180	LOS ANGELES, CA	45,798	870,728	1,630	1,564	1.04
83	CHICAGO, IL	125	DALLAS-FORT WORTH, TX	45,016	688,780	992	965	1.03
186	QUEBEC	83	CHICAGO, IL	40,220	700,380	835	851	0.98
4	BOSTON, MA	83	CHICAGO, IL	37,699	400,840	1,006	992	1.01
83	CHICAGO, IL	172	PORTLAND, OR	37,439	452,000	2,193	2,122	1.03
179	FRESNO-BAKERSFIELD, CA	83	CHICAGO, IL	37,107	774,148	2,301	2,154	1.07
180	LOS ANGELES, CA	55	MEMPHIS, TN	34,965	501,730	2,104	1,803	1.17
18	PHILADELPHIA, PA	83	CHICAGO, IL	34,806	469,200	836	785	1.06
172	PORTLAND, OR	83	CHICAGO, IL	34,333	715,140	2,194	2,122	1.03
180	LOS ANGELES, CA	122	HOUSTON, TX	34,324	558,792	1,630	1,564	1.04
172	PORTLAND, OR	180	LOS ANGELES, CA	32,390	734,640	1,091	960	1.14
19	BALTIMORE, MD	83	CHICAGO, IL	32,147	438,180	811	773	1.05
180	LOS ANGELES, CA	125	DALLAS-FORT WORTH, TX	31,753	467,492	1,639	1,438	1.14
180	LOS ANGELES, CA	105	KANSAS CITY, MO	29,818	468,400	1,739	1,618	1.07
105	KANSAS CITY, MO	180	LOS ANGELES, CA	29,799	493,628	1,739	1,618	1.07
180	LOS ANGELES, CA	113	NEW ORLEANS, LA	28,960	482,208	1,990	1,913	1.04

Table 5

Double Stack Network For Year 1987

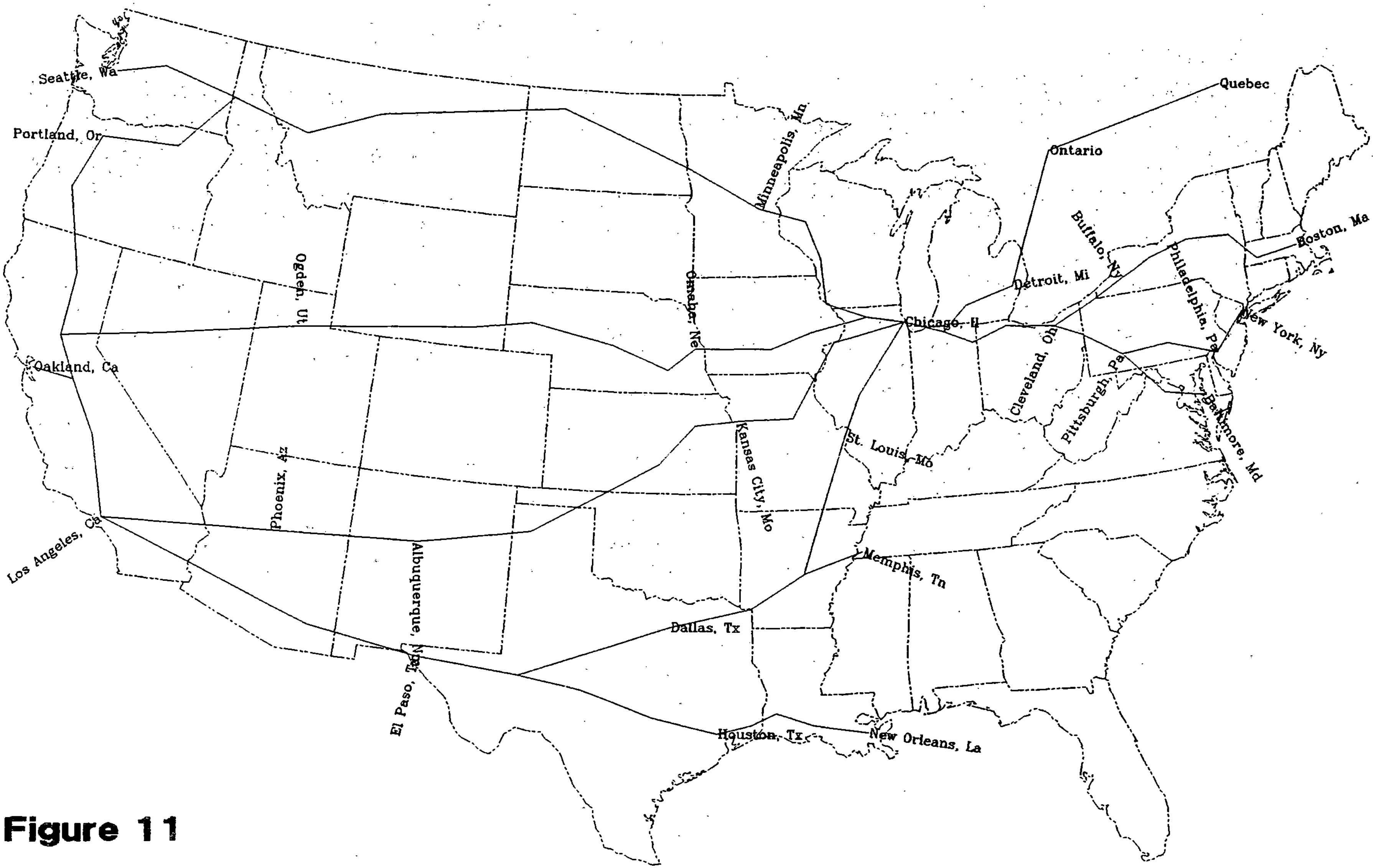


Figure 11

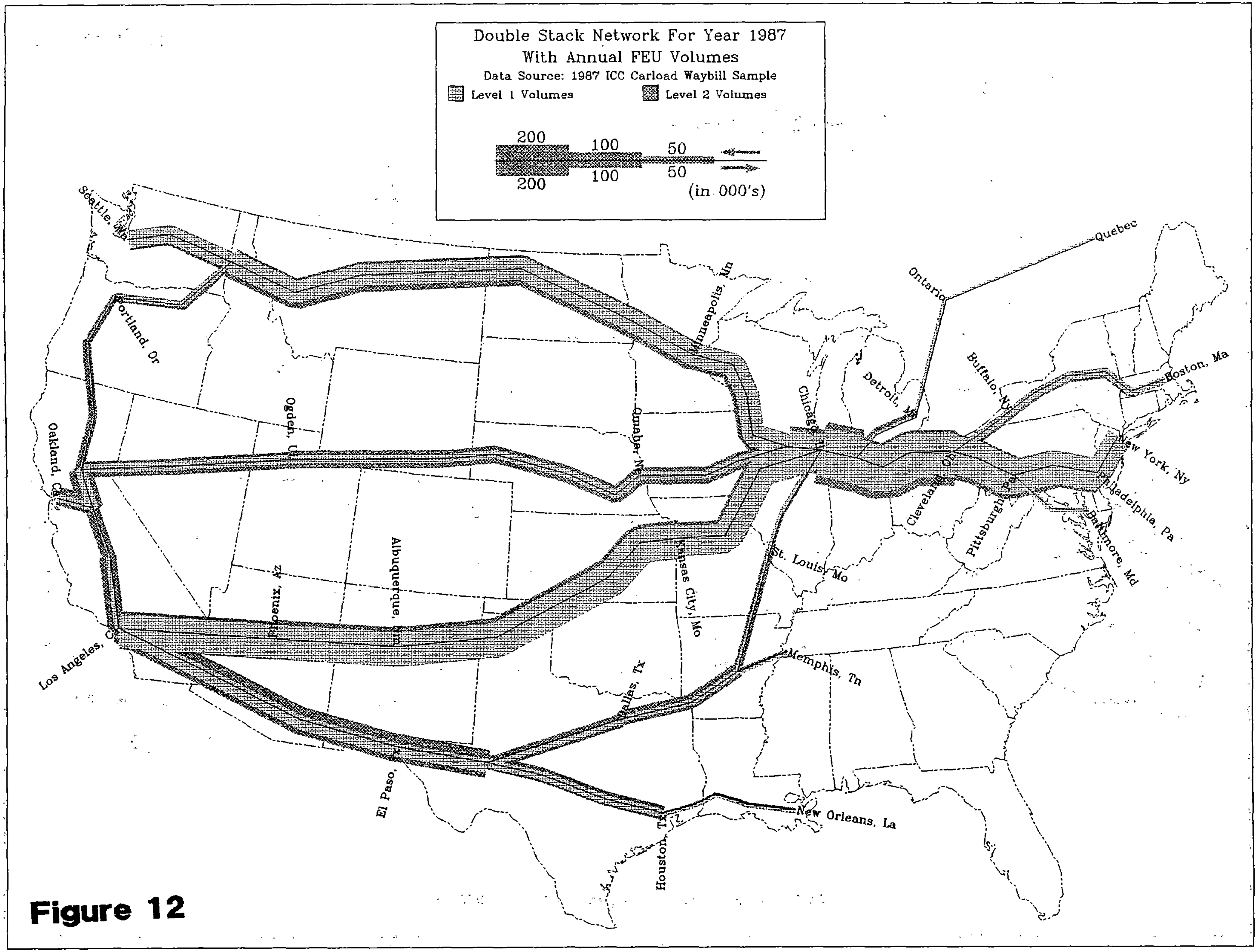

Double Stack Network For Year 1987
With Annual FEU Volumes
Data Source: 1987 ICC Carload Waybill Sample
Level 1 Volumes
Level 2 Volumes
200
100
50
200
100
50
(in 000's)
Seattle, Wa
Portland, Or
Oakland, Ca
Los Angeles, Ca
Ogden, Ut
Phoenix, Az
Albuquerque, Nm
El Paso, Tx
Minneapolis, Mn
Omaha, Ne
Kansas City, Mo
Dallas, Tx
Houston, Tx
Chicago, Il
St. Louis, Mo
Memphis, Tn
New Orleans, La
Detroit, Mi
Ontario
Quebec
Buffalo, Ny
Cleveland, Oh
Pittsburgh, Pa
Boston, Ma
New York, Ny
Philadelphia, Pa
Baltimore, Md

Figure 12

for this study, fully competitive with truckload carriers. These services are still limited, however, by the distance containers can be drayed on either end of the trip. After review of the relationship between time, distance, and drayage costs, it was determined that extended drays (sometimes 200 miles or more in the direction of movement) were feasible on one, but not both ends of a truck-competitive double-stack movement. The feasible drayage patterns were converted to geographic equivalents, as illustrated in Figure 13. The validity of this conclusion is supported by the pattern of actual truck diversions. Review of the underlying NMTDB data and comparisons with previous years indicate clearly that significant truck diversions have already occurred in major double-stack corridors, most noticeably between Los Angeles and Chicago proper. Growth of truckload traffic in those corridors has been flat relative to growth elsewhere. Also, a survey taken by Trailer Train suggests that containerized imports formerly transloaded to trucks in Southern California have been diverted to through movement by rail.

Divertible movements were identified from NMTDB data using this drayage criterion. These truckload flows are shown in Figure 14. Because of the data-collection structure of the NMTDB and the configuration of the highway system, divertible truck flows within the eastern states (i.e., Boston to Chicago) could not be identified.

The addition of diverted truck traffic would justify service on additional corridors and to additional intermediate points. Table 6 gives an expanded list of corridors, and Figure 15 illustrates the expanded network flows including volumes from intermediate points.

The diversion of additional large-scale truck traffic is subject to strong caveats. The cost criteria used to determine the minimum competitive length of haul incorporate favorable assumptions regarding double-stack cost and trucking costs. Failure to achieve the potential economies of double-stack line-hauls or significant variations in trucking costs could markedly alter the cost criteria, and thus the prospects of diverting a given truck flow. Also, truck repositioning practices may negate the ability of double-stack services to attract poorly balanced traffic flows without excessive drayage

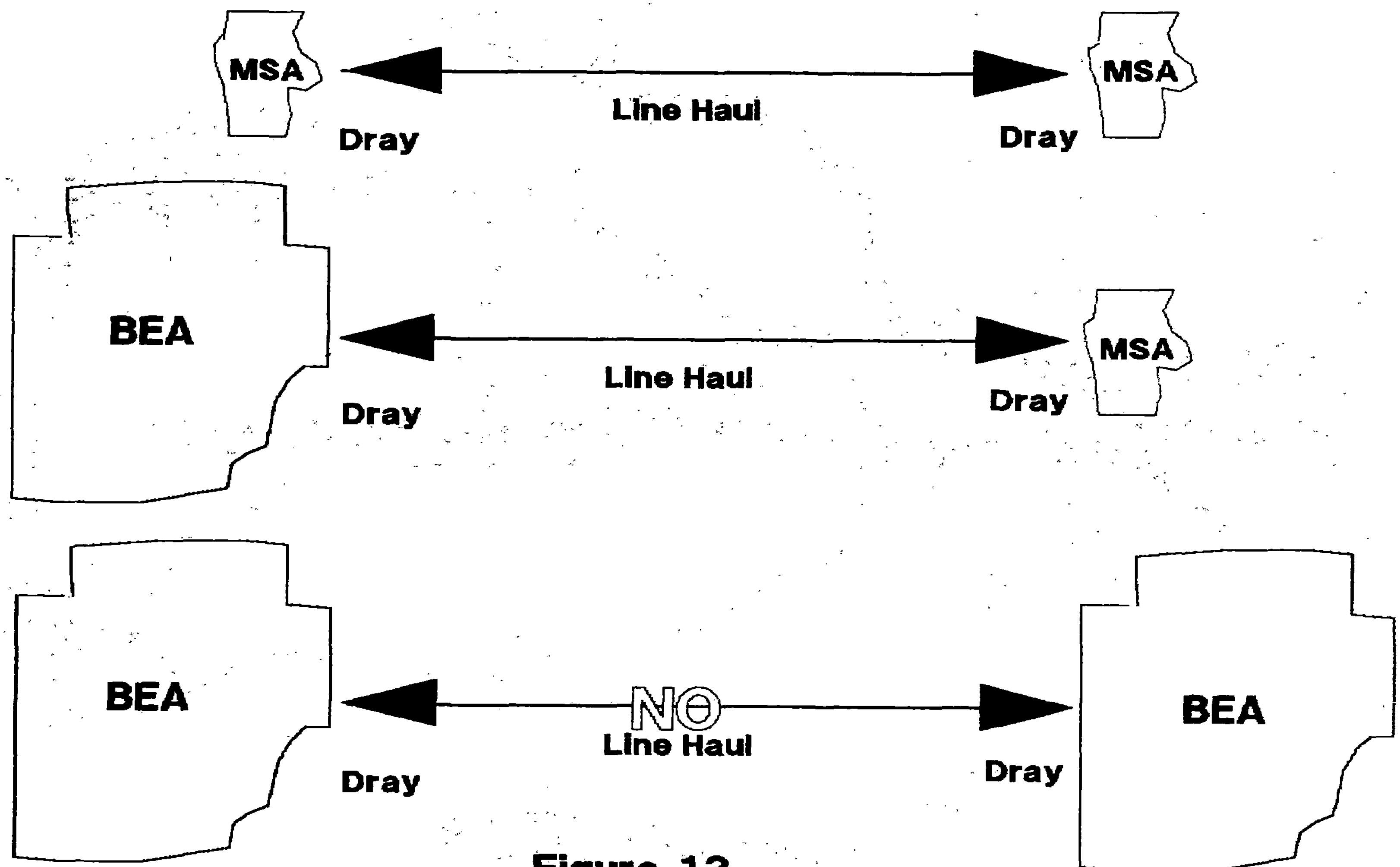
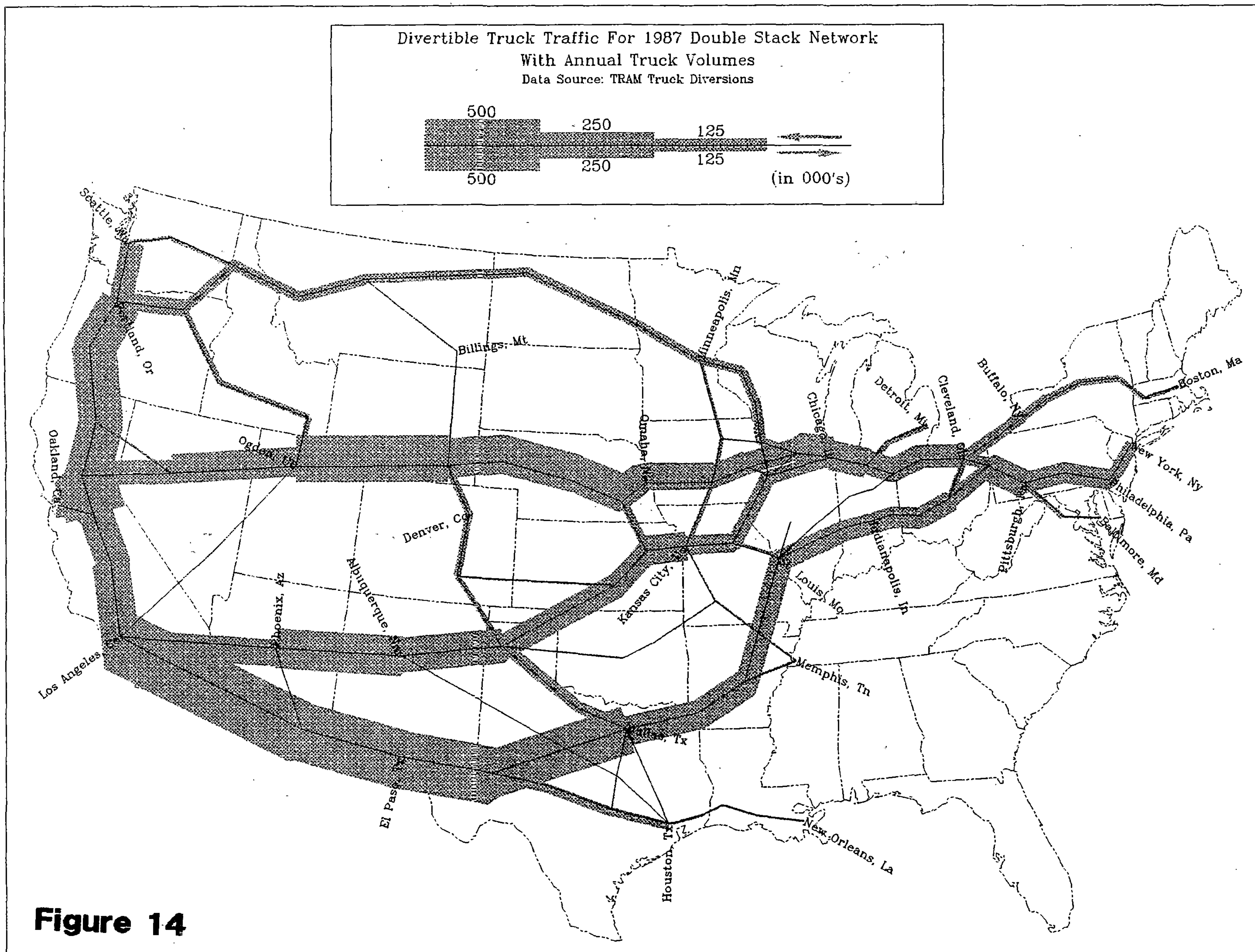


Figure 13

GEOGRAPHIC DRAYAGE PATTERNS



Divertible Truck Traffic For 1987 Double Stack Network
With Annual Truck Volumes
Data Source: TRAM Truck Diversions
500
250
125
(in 000's)
Seattle, Wa
Portland, Or
Oakland, Ca
Ogden, Ut
Billings, Mt
Denver, Co
Minneapolis, Mn
Omaha
Chicago
Detroit, Mi
Cleveland, Oh
Buffalo, Ny
Boston, Ma
New York, Ny
Philadelphia, Pa
Baltimore, Md
Pittsburgh
Indianapolis, In
St. Louis, Mo
Kansas City, Mo
Memphis, Tn
Dallas, Tx
Houston, Tx
New Orleans, La
El Paso
Albuquerque
Phoenix, Az
Los Angeles

Figure 14

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES
AND ANNUAL TRAM PLUS WAYBILL FEU VOLUME OF AT LEAST 60 PERCENT OF 46,800
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL TOTAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

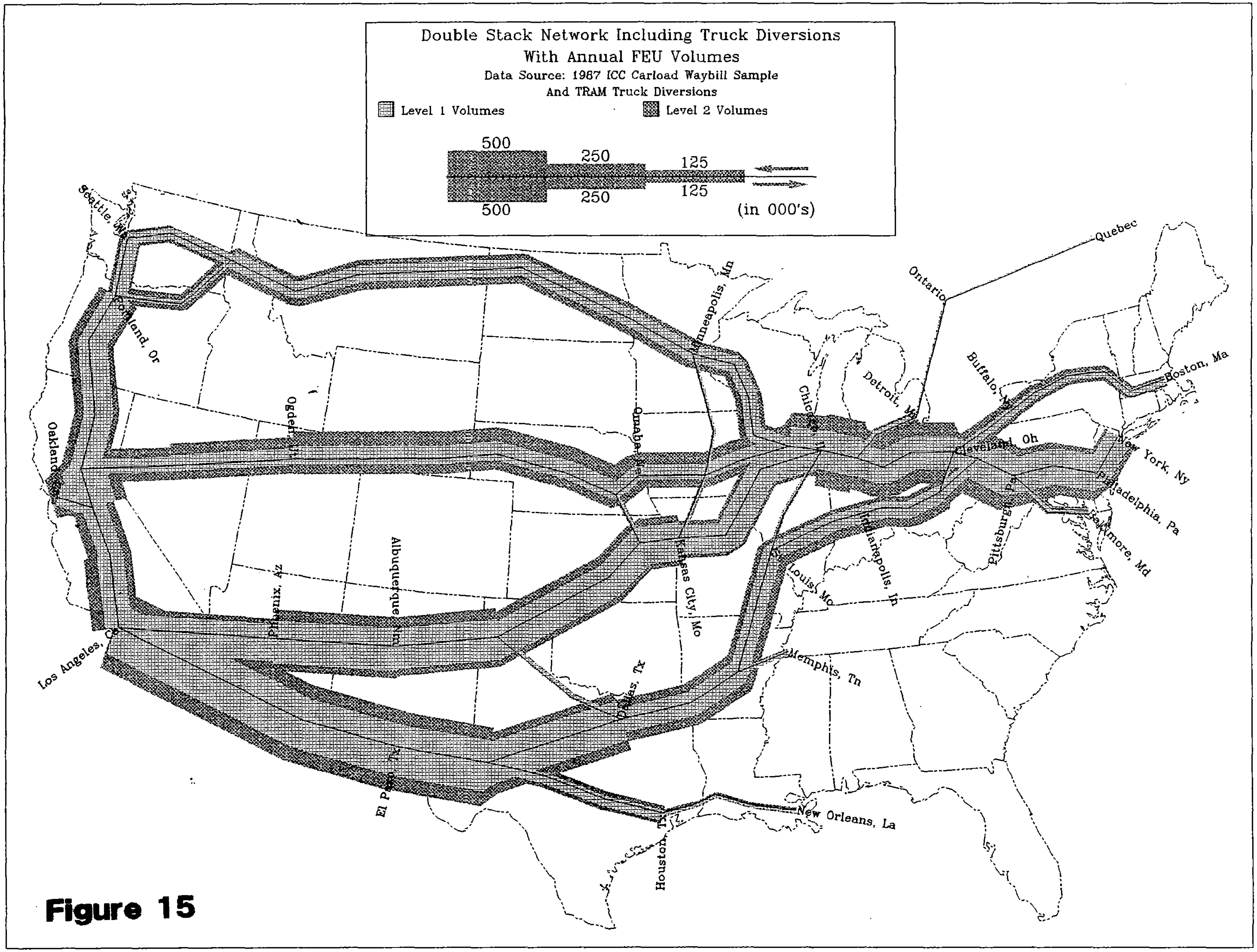
ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
180 LOS ANGELES, CA	83 CHICAGO, IL	2,199	2,040	1.08	187,054	67,500	254,554
83 CHICAGO, IL	180 LOS ANGELES, CA	2,199	2,040	1.08	160,377	44,352	204,729
125 DALLAS-FORT WORTH, TX	180 LOS ANGELES, CA	1,639	1,438	1.14	8,997	156,084	165,081
83 CHICAGO, IL	12 NEW YORK, NY	904	815	1.11	159,045	0	159,045
12 NEW YORK, NY	83 CHICAGO, IL	904	815	1.11	144,595	0	144,595
180 LOS ANGELES, CA	12 NEW YORK, NY	3,106	2,789	1.11	25,983	96,192	122,175
180 LOS ANGELES, CA	125 DALLAS-FORT WORTH, TX	1,639	1,438	1.14	31,753	88,992	120,745
83 CHICAGO, IL	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,222	2,120	1.05	59,385	61,308	120,693
180 LOS ANGELES, CA	171 SEATTLE, WA	1,274	1,133	1.12	4,141	112,008	116,149
171 SEATTLE, WA	83 CHICAGO, IL	2,166	2,080	1.04	113,753	0	113,753
83 CHICAGO, IL	171 SEATTLE, WA	2,166	2,080	1.04	103,159	0	103,159
180 LOS ANGELES, CA	122 HOUSTON, TX	1,630	1,564	1.04	34,324	68,016	102,340
172 PORTLAND, OR	180 LOS ANGELES, CA	1,091	960	1.14	32,390	63,156	95,546
180 LOS ANGELES, CA	172 PORTLAND, OR	1,091	960	1.14	11,651	82,404	94,055
83 CHICAGO, IL	18 PHILADELPHIA, PA	836	785	1.06	79,559	0	79,559
125 DALLAS-FORT WORTH, TX	162 PHOENIX, AZ	1,328	1,080	1.23	2,742	71,448	74,190
171 SEATTLE, WA	180 LOS ANGELES, CA	1,274	1,133	1.12	6,223	56,940	63,163
83 CHICAGO, IL	172 PORTLAND, OR	2,193	2,122	1.03	37,439	24,696	62,135
180 LOS ANGELES, CA	55 MEMPHIS, TN	2,104	1,803	1.17	34,965	25,872	60,837
12 NEW YORK, NY	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	3,315	2,902	1.14	6,785	51,672	58,457
83 CHICAGO, IL	4 BOSTON, MA	1,006	992	1.01	56,220	0	56,220
18 PHILADELPHIA, PA	180 LOS ANGELES, CA	3,038	2,734	1.11	2,022	53,520	55,542
122 HOUSTON, TX	180 LOS ANGELES, CA	1,630	1,564	1.04	45,798	8,664	54,462
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	83 CHICAGO, IL	2,222	2,120	1.05	53,234	0	53,234
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	171 SEATTLE, WA	923	811	1.14	1,033	50,928	51,961
83 CHICAGO, IL	19 BALTIMORE, MD	811	773	1.05	49,160	0	49,160
180 LOS ANGELES, CA	113 NEW ORLEANS, LA	1,990	1,913	1.04	28,960	18,504	47,464
180 LOS ANGELES, CA	4 BOSTON, MA	3,221	3,034	1.06	6,781	40,476	47,257
12 NEW YORK, NY	180 LOS ANGELES, CA	3,106	2,789	1.11	12,463	34,716	47,179
71 DETROIT, MI	180 LOS ANGELES, CA	2,451	2,291	1.07	11,338	35,496	46,834
172 PORTLAND, OR	83 CHICAGO, IL	2,194	2,122	1.03	34,333	12,348	46,681
179 FRESNO-BAKERSFIELD, CA	83 CHICAGO, IL	2,301	2,154	1.07	37,107	8,088	45,195
83 CHICAGO, IL	125 DALLAS-FORT WORTH, TX	992	965	1.03	45,016	0	45,016
178 STOCKTON-MODESTO, CA	125 DALLAS-FORT WORTH, TX	1,861	1,757	1.06	3,746	40,080	43,826
178 STOCKTON-MODESTO, CA	171 SEATTLE, WA	883	804	1.10	207	43,272	43,479
171 SEATTLE, WA	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	923	811	1.14	1,797	39,132	40,929
180 LOS ANGELES, CA	160 ALBUQUERQUE, NM	893	796	1.12	2,530	38,136	40,666
125 DALLAS-FORT WORTH, TX	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,939	1,791	1.08	4,612	35,688	40,300
186 UNKNOWN	83 CHICAGO, IL	835	851	0.98	40,220	0	40,220
55 MEMPHIS, TN	180 LOS ANGELES, CA	2,104	1,803	1.17	27,539	12,288	39,827
180 LOS ANGELES, CA	96 MINNEAPOLIS-ST. PAUL, MN	2,143	1,936	1.11	1,508	36,840	38,348
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	172 PORTLAND, OR	739	638	1.16	6,943	30,852	37,795
4 BOSTON, MA	83 CHICAGO, IL	1,006	992	1.01	37,699	0	37,699
180 LOS ANGELES, CA	105 KANSAS CITY, MO	1,739	1,618	1.07	29,818	7,368	37,186
162 PHOENIX, AZ	125 DALLAS-FORT WORTH, TX	1,328	1,080	1.23	602	35,832	36,434
105 KANSAS CITY, MO	165 SALT LAKE CITY-OGDEN, UT	1,138	1,055	1.08	3,588	32,784	36,372
18 PHILADELPHIA, PA	83 CHICAGO, IL	836	785	1.06	34,806	0	34,806

Table 6

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES
AND ANNUAL TRAM PLUS WAYBILL FEU VOLUME OF AT LEAST 60 PERCENT OF 46,800
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL TOTAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
83 CHICAGO, IL	164 RENO, NV	1,982	1,904	1.04	5,434	28,524	33,958
19 BALTIMORE, MD	83 CHICAGO, IL	811	773	1.05	32,147	0	32,147
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	105 KANSAS CITY, MO	2,017	1,770	1.14	7,286	24,696	31,982
180 LOS ANGELES, CA	71 DETROIT, MI	2,451	2,291	1.07	857	30,768	31,625
173 EUGENE, OR	180 LOS ANGELES, CA	966	854	1.13	27,371	4,140	31,511
178 STOCKTON-MODESTO, CA	83 CHICAGO, IL	2,182	2,087	1.05	19,017	12,348	31,365
9 ROCHESTER, NY	180 LOS ANGELES, CA	2,819	2,619	1.08	410	30,444	30,854
105 KANSAS CITY, MO	180 LOS ANGELES, CA	1,739	1,618	1.07	29,799	0	29,799
180 LOS ANGELES, CA	20 WASHINGTON, DC	3,010	2,664	1.13	160	28,320	28,480
					1,945,881	1,844,892	3,790,773

Table 6



Double Stack Network Including Truck Diversions
With Annual FEU Volumes
Data Source: 1987 ICC Carload Waybill Sample
And TRAM Truck Diversions
Level 1 Volumes
Level 2 Volumes
500
250
125
125
250
500
(in 000's)
Quebec
Ontario
Minneapolis, Mn
Portland, Or
Buffalo, Ny
Boston, Ma
Detroit, Mi
Chicago
Cleveland, Oh
New York, Ny
Philadelphia, Pa
Baltimore, Md
Pittsburgh, Pa
Indianapolis, In
Omaha
Ogden
Oakland
Kansas City, Mo
Louis, Mo
Albuquerque, Nm
Phoenix, Az
Los Angeles, Ca
Memphis, Tn
Dallas, Tx
El Paso
New Orleans, La
Houston, Tx

Figure 15

costs. Finally, double-stack reliability and service quality must approach or equal the truckload standard.

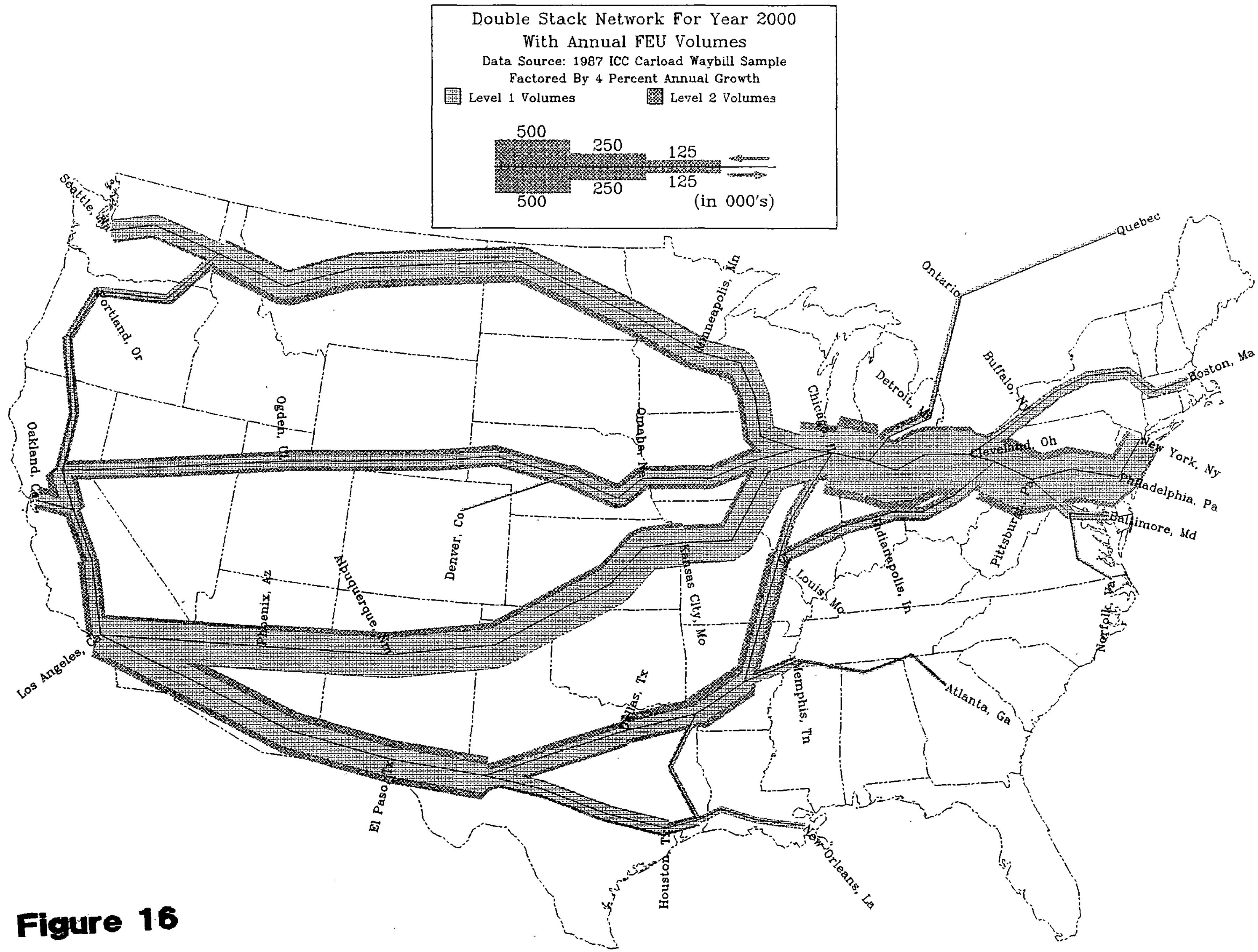
C. Year 2000 Double-Stack Network

Candidate 1987 rail traffic flows were expanded to projected year 2000 levels at a 4 percent annual rate of growth, derived from a range of published forecasts. Additional corridors would reach the volume threshold required for truck-competitive domestic double-stack service. Additional intermediate point flows would also qualify, and Figure 16 shows the combined year 2000 traffic flows.

D. Network Overview

The hypothetical 1987 network described in the preceding tables and figures includes corridors where, according to the service and cost criteria derived herein and the traffic data available from 1987, double-stack services could be fully competitive with truckload service. It should come as no surprise that this network includes the long-distance, high-volume double-stack services now operating, and most of the high-volume trailer flows. This network, however, is focused on the ability to attract domestic truck traffic. Accordingly, it does not include some existing double-stack movements of domestic or international containers, especially those that developed between 1987 and 1990.

The flows developed here could be described as a "core network" of services able to hold their own in direct competition with truckload carriers. The inclusion of intermediate points anticipates a maturation of the network, and an integration of double-stack services into overall rail operations, that is now just beginning. The train system that American President Intermodal superimposes on the railroad network offers service to and from some intermediate points such as Salt Lake City and Fresno. The presence of major customers has also led to double-stack service to Modesto, California, Newton, Iowa, and Marysville, Ohio. Much of the traffic generated at intermediate points is



Double Stack Network For Year 2000
With Annual FEU Volumes
Data Source: 1987 ICC Carload Waybill Sample
Factored By 4 Percent Annual Growth
Level 1 Volumes
Level 2 Volumes
500
250
125
250
125
500
(in 000's)
Seattle, Wa
Portland, Or
Oakland, Ca
Ogden, Ut
Denver, Co
Omaha, Ne
Minneapolis, Mn
Chicago, Il
Detroit, Mi
Ontario
Quebec
Buffalo, Ny
Boston, Ma
Cleveland, Oh
New York, Ny
Philadelphia, Pa
Baltimore, Md
Pittsburgh, Pa
Indianapolis, In
St. Louis, Mo
Kansas City, Mo
Norfolk, Va
Los Angeles, Ca
Phoenix, Az
Albuquerque, Nm
El Paso, Tx
Dallas, Tx
Houston, Tx
Memphis, Tn
Atlanta, Ga
New Orleans, La

Figure 16

still carried in boxcars, and presents a real challenge to marketers of domestic container service.

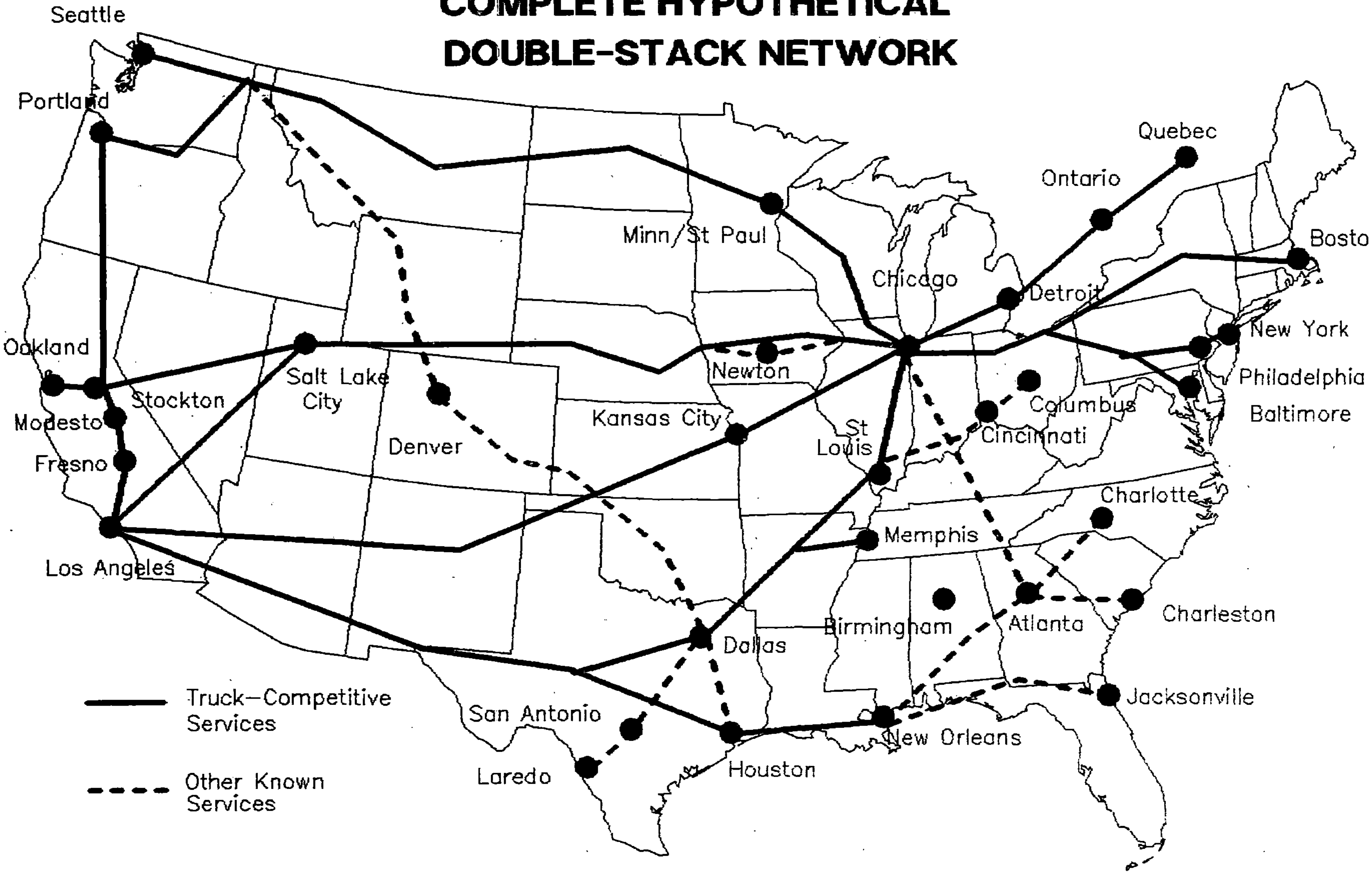
The data processing performed for this study did not distinguish among different railroads or routes serving the same endpoints. Yet service to some intermediate points depends on through service to major hubs on the same railroad: if the railroad in question does not offer fully competitive service to the major hubs, service to intermediate points may not develop. Counterbalancing this uncertainty is the possibility that creative operations planners could combine end-to-end flows to create higher service frequencies at midpoints. Another possibility, and one that has already occurred in some instances, is that one or more major shippers could generate double-stack flows on a less frequent basis and still obtain service.

Figure 17 combines the network shown in Figure 11 with the additional double-stack services being offered in late 1989 (shown on Figure 9) to display a more complete hypothetical double-stack network. This more complete network thus includes routes that will or already have double-stack service because:

- double-stack service can be fully truck-competitive (the core network);
- double-stack service is provided for international flows, or
- double-stack service is being provided under contract for specific domestic shippers, regardless of its ability to compete for common carriage.

The actual routing of double-stack services will, of course, vary from the schematic routes shown in Figure 17. By merging traffic to and from several sources, railroad operations planners may be able to justify frequent domestic double-stack services that are not identifiable from the Carload Waybill Sample alone. Moreover, refinements in operations may permit increased frequency or extensions of service to points not shown; combining, splitting, or

Figure 17
COMPLETE HYPOTHETICAL DOUBLE-STACK NETWORK



Note: Lines indicate service corridors, not specific railroad routes blocking trains may enable individual rail systems or other double-stack operators to serve corridors that cannot be justified from city-pair data.

E. Major Trends and Data Adequacy

The tables and figures incorporated in this section portray the potential truck-competitive network in considerable detail. More complete and exact findings could be presented were better data available. The three primary data sources used in this study were designed before the advent of double-stack operations, and were not designed to be combined for this purpose. Any bias introduced by current data shortcomings is probably conservative: more flows would likely qualify for inclusion in the network if better data were available. To the extent that detailed public or private planning for double-stack container transportation depends on such issues, the adequacy of publicly available data must be examined. For the purpose of understanding the major trends in double-stack service and domestic containerization, the data presented herein appear sufficient. With some few exceptions, the criteria and network configurations developed herein correspond to the major developments observable in the marketplace.

F. Sensitivity to Truck Costs

The ability of double-stack services to attract and retain domestic traffic is sensitive to changes in trucking costs. The minimum truck-competitive length of haul used in this study, 725 miles, was derived from a comparison of double-stack and truckload operating costs. Should truckload costs rise relative to rail costs, the minimum length of haul will decline (although not below the minimum service-competitive distance of 540 miles). Should truckload costs decline, the minimum length of haul will rise. Each one cent per mile change in truck costs would shift the minimum length of truck-competitive double-stack hauls by 11 miles.

Were truck size and weight limits relaxed to allow widespread use of Large Combination Vehicles such as twin 48-foot trailers, truckload costs would decline markedly. According to estimates by the Association of American Railroads, the use of twin 48's would reduce truckload unit operating costs by roughly 30 percent. Using the same cost criteria employed earlier, this reduction would increase the minimum length of haul for truck-competitive double-stack services to 1,212 miles, effectively eliminating such services within the eastern United States. It is widely conceded, however, that increases in truck size and weight limits would be offset to some extent by increases in fuel or use taxes and labor costs.

Fuel costs may rise due to higher costs for crude oil, a requirement for "cleaner" fuel, or higher fuel taxes. Cleaner fuel, which may be required for 1994 emissions standards, is expected to cost an additional 3-4 cents per gallon. Fuel tax proposals range from 5 to 25 cents per gallon. Since truckload carriers get about 5.6 miles per gallon, each one cent per gallon increase in fuel costs increases truckload operating costs by .18 cents per mile. The most dramatic increase, a 25-cent tax and a 4-cent increase for cleaner fuel, would raise operating costs by 5.18 cents per mile and reduce the minimum truck-competitive double-stack length of haul from 725 miles to 670 miles. Truck labor costs have risen in the last few years, due in part to a driver shortage. Should these conditions persist, increases in trucking costs will make more existing truck traffic susceptible to diversion by double-stack services.

G. The Domestic and International Container Mix

The first double-stack trains carried international containers eastbound, and a mix of international, domestic, and empty containers westbound. As eastbound domestic traffic was developed on the West Coast, eastbound trains also carried a mix of domestic and international traffic. At present, many double-stack trains carry a mix. The major exceptions are solid trains of import containers generated by specific ship arrivals, and API's Detroit-Dallas domestic trains (which could, conceivably, carry any international traffic that moved in that corridor). Because both international and domestic containers are usually tendered by ocean carrier affiliates or other third parties, the railroads do not routinely distinguish between domestic and international containers, but handle each in accordance with the customer's instructions.

The advent of 48-foot-long, 102-inch-wide domestic containers raises questions concerning their compatibility with ISO marine containers (which are a maximum of 45 feet long and 96 inches wide) aboard double-stack cars and in intermodal terminals. From all indications, it appears that the technical compatibility of domestic and international containers will remain an issue to be addressed in terminal and train operations, but it will not be a significant barrier to expansion of domestic or international double-stack services. Early double-stack cars cannot accept 48-foot long containers or 102-inch wide containers in the bottom well. Most can, however, carry 48-foot domestic containers on the top, because such containers have fittings on the bottom designed to connect with ISO containers. Moreover, double-stack cars in current production can accommodate either domestic or ISO containers in all positions. Within intermodal terminals, care must be taken to match container sizes with car positions and with chassis types. The use of newer, more flexible cars and adjustable chassis has simplified this task. Electronic Data Interchange (EDI) and Automatic Equipment Identification (AEI) technologies will help, but only if their capabilities are exploited in actual terminal operations.

H. Double-Stack Equipment and Investment Needs

Table 7 gives the traffic sources for the hypothetical 1987 double-stack network. Of the 5,944,513 total annual loads, 4,752,829 (all but the existing container traffic) would require new domestic containers (assuming none were carried in surplus ISO containers). At a representative utilization rate of 18 annual loads per container, this traffic volume would require 264,046 new domestic containers (Table 8). Growth to the year 2000 would require an additional 56,437 domestic containers. In 1989 dollars, a new 48 x 102 domestic container costs roughly $8,000. The cost of containers needed to serve the hypothetical 1987 network, including all the truck diversions, would be approximately $2,112 million. The additional cost for the year 2000 is $451 million.

Major intermodal ocean carriers own approximately one chassis for each two containers. This ratio can be used as a rough guideline for estimating the total chassis fleet required to support the hypothetical 1987 and 2000

Table 7

1987 DOUBLE-STACK NETWORK TRAFFIC SOURCES

	Relevant 1987 Total	Major Corridors	Intermediate Points	Network Total	Other Intermodal	Non-Intermodal*
Containers	2,277,484	995,322	196,362	1,191,684	1,085,800	--
Trailers	2,972,591	763,290	345,374	1,108,664	1,863,927	--
Boxcars (Ctr Eqv)	3,107,496	187,269	220,292	407,561	--	2,699,935
Trucks	4,105,104	1,844,892	1,391,712	3,236,604	--	868,500
TOTAL	12,462,675	3,790,773	2,153,740	5,944,513	2,949,727	3,568,435

*Near-term conversion to double-stacked containers is not expected for this traffic.

Source: Final Study Report.

Table 8

RAIL EQUIPMENT NEEDS

	1987 NETWORK			2000 ADDITIONAL		
	Units	1987 Price ($)	Cost ($ M)	Units	1987 Price ($)	Cost ($ M)
48' x 102" Domestic Containers						
For existing trailer traffic	61,592	8,000	493	41,267	8,000	330
For converted boxcar traffic	22,642	8,000	181	15,170	8,000	121
For diverted truck traffic	179,811	8,000	1,438	-	-	-
SUBTOTAL	264,046	8,000	2,112	56,437	8,000	451
48' Chassis	132,023	6,500	858	28,219	6,500	183
Double-Stack Cars	5,281	180,000	951	1,129	180,000	203
TOTAL			3,921			837

double-stack networks. Approximately 132,023 additional chassis would have been required in 1987, and another 28,219 by 2000. 1989 costs were roughly $8,500 for an extendable 40/45/48 chassis. With standardization of domestic containers at 48 feet, however, extendable chassis may not be needed. A 48-foot fixed-length chassis would cost closer to $6,500, making the cost about $858 million, and the 2000 cost about $183 million (Table 8).

In 1988 there were approximately 2,400,000 rail container loadings. The majority were apparently on double-stack cars, of which there were about 2,400 (24,000 container spaces). This suggests that double-stack cars were making up to 100 loaded trips per year, or about one round-trip per week. This estimate implies a very high utilization, which in fact is being achieved. A five-unit double-stack car is therefore capable of carrying 1,000 annual container (100 trips at 10 containers each). If one container makes 10 annual round trips (loaded or empty), each double-stack car can support a fleet of approximately 50 containers. The additional containers listed in Table 8 would therefore require an additional 5,281 double-stack cars for the 1987 network, and 1,129 additional cars for the 2000 network. At a current cost of approximately $180,000 per car, the total cost would be $951 million for the 1987 network, and an additional $203 million for the 2000 network (Table 8).

Total Equipment Needs. Table 8 summarizes the needs for domestic containers, chassis, and double-stack cars. The total investment need is roughly $3.9 billion for the hypothetical 1987 network, and an additional $0.8 billion by the year 2000. The total investment for the 13 year period is about $4.8 billion, or $366 million per year. Although high, this figure is not unattainable: the railroad industry made a similar total investment during the coal boom of the late 1970's and early 1980's, when the industry was not as prosperous as it is now. To the extent that container and trailer traffic outside the truck-competitive network is also converted to double-stacked containers, there will be additional equipment investment needs.

In recent years, the intermodal industry has relied heavily on Trailer Train for cars, and on leasing companies for containers and chassis. This trend is likely to continue, although the ICC prohibition of car assignment by Trailer

Train has already led railroads to purchase or lease more double-stack cars. Nonetheless, relatively little of this capital cost would be borne directly by the railroads.

I. Rail Intermodal Terminal Facilities

Consolidated traffic volumes at hub cities for the 1987 and 2000 hypothetical double-stack networks were estimated to determine the ability of rail intermodal terminal facilities to handle the increased traffic. Table 9 lists estimated potential capacities for existing facilities at most major hubs, and compares those capacities with hypothetical traffic volumes to identify shortfalls. Potential capacities were estimated by assuming that two-thirds of track length was available for loading and unloading, and that a double-stack train required 12 hours to unload and load. The shortfalls thus identified reflect the need for expanding or constructing facilities, rather than merely adding lift machines or personnel. The cost of expansion or construction was estimated at roughly $505,000 per acre, based on recent projects in Los Angeles, Seattle, and Tacoma. Table 9 indicates the estimated cost of adding the required capacity at each major hub city. The total is approximately $4.7 million for 1987 traffic, and $40.2 million for 2000 traffic.

Railroads have repeatedly demonstrated their willingness to expand and improve intermodal terminals to meet the needs of growing traffic, after maximizing the utilization of existing terminals. Railroads often view expanded and improved facilities as a means of attracting business, and expanding market share. Although the total cost shown in Table 9 is substantial, it will not be a barrier if the railroads are convinced that intermodal traffic would grow to that extent and return adequate profits.

A greater terminal capacity problem may occur at smaller points that do not have intermodal facilities, or that do not have mechanical lift equipment. At points that only generate boxcar traffic beyond the reach of existing hubs, railroads would be running substantial risks to build intermodal terminals in hopes of converting that traffic to containers. The minimum volumes required to initiate double-stack service to intermediate points on major corridors may

Table 9
POTENTIAL TERMINAL CAPACITY SHORTFALL

Hub	Estimated Capacity	Hypothetical 1987 Volume	Hypothetical 2000 Volume	1987 Surplus or Shortfall	2000 Surplus or Shortfall	1987 Expansion Cost ($)	2000 Expansion Cost ($)
LA/LB	3,026,735	2,659,382	3,364,201	367,353	(337,466)		13,847,698
Seattle	1,080,141	844,907	1,144,784	235,234	(64,643)		2,652,584
Portland	584,687	594,863	768,158	(10,176)	(183,471)	417,566	7,528,613
Chicago	7,423,814	2,660,493	4,232,317	4,763,321	3,191,497		
St Paul	120,016	225,548	327,672	(105,532)	(207,656)	4,330,437	8,521,029
Detroit	569,673	246,806	334,942	322,867	234,731		
Kansas City	872,403	400,771	613,703	471,632	258,700		
Denver	644,962	141,245	235,191	503,717	409,771		
Houston	948,416	412,981	619,449	535,435	328,967		
St Louis	878,163	362,198	597,337	515,965	280,826		
Columbus	240,031	75,979	126,515	164,052	113,516		
New York	1,215,485	791,433	1,131,262	424,052	84,223		
Baltimore	418,591	184,255	278,501	234,336	140,090		
New Orleans	395,173	316,849	497,857	78,324	(102,684)		4,213,571
Atlanta	790,473	263,756	439,172	526,717	351,301		
Memphis	453,718	343,797	536,416	109,921	(82,698)		3,393,459
Dallas-Ft Worth	INC.DATA	800,277	1,013,483				
SF-Oakland	INC.DATA	827,151	1,054,579				
Philadelphia	INC.DATA	343,545	489,552				
Boston	INC.DATA	225,841	322,769				
Stockton-Modesto	UNKNOWN	344,721	396,251				
Phoenix	UNKNOWN	338,197	392,406				
Albuquerque	UNKNOWN	66,492	75,554				
Salt Lake City	UNKNOWN	181,884	232,065				
Fresno-Bakersfield	UNKNOWN	213,101	263,549				
TOTAL	19,662,481	13,866,472	19,487,685	9,137,218	4,415,004	4,748,003	40,156,955

not be sufficient to justify investment in mechanical lift facilities in marginal locations.

The need for railroad investment in terminal facilities will be mitigated by the current trend toward shipper and third-party ownership of terminals. Recent examples include API terminals in South Kearny, New Jersey and Woodhaven, Michigan; Rail-Bridge terminals in Elizabeth, New Jersey and LaColle, Quebec; and a projected UPS terminal in Chicago.

V. IMPLICATIONS FOR RAILROADS

A. Double-Stack Service Functions

Five principal functions must be performed in developing and operating a domestic door-to-door double-stack service:

- o Market development, marketing, sales, and customer service;
- o Equipment provision and maintenance;
- o Terminal operations;
- o Origin and destination drayage; and
- o Line-haul operations.

As shown in Figure 18, the static roles of railroads, ocean carriers, agents, and lessors in 1980 have given way to more dynamic and changeable roles. Of these five principal functions, only line-haul operations remain the exclusive domain of the railroads.

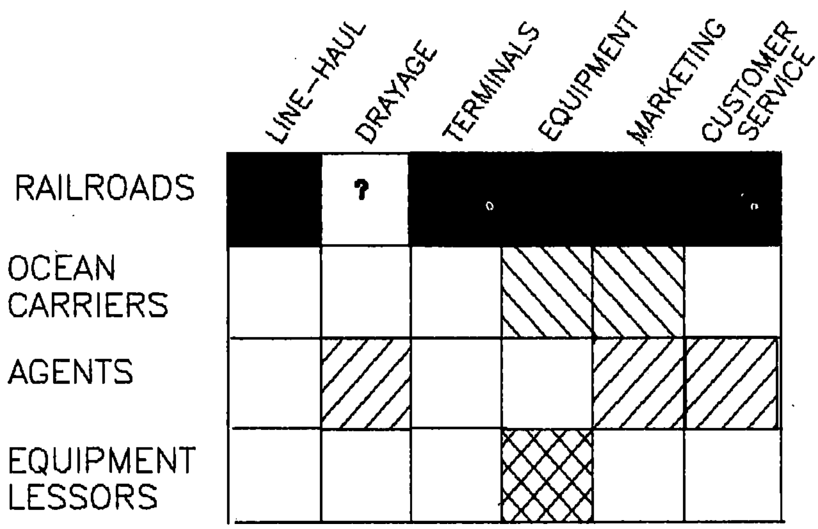
For some years, intermodal marketing and customer service functions have been split:

- o Railroads market "wholesale" to third parties, ocean carriers, and major national accounts such as UPS, the Postal Service, and LTL motor carriers.

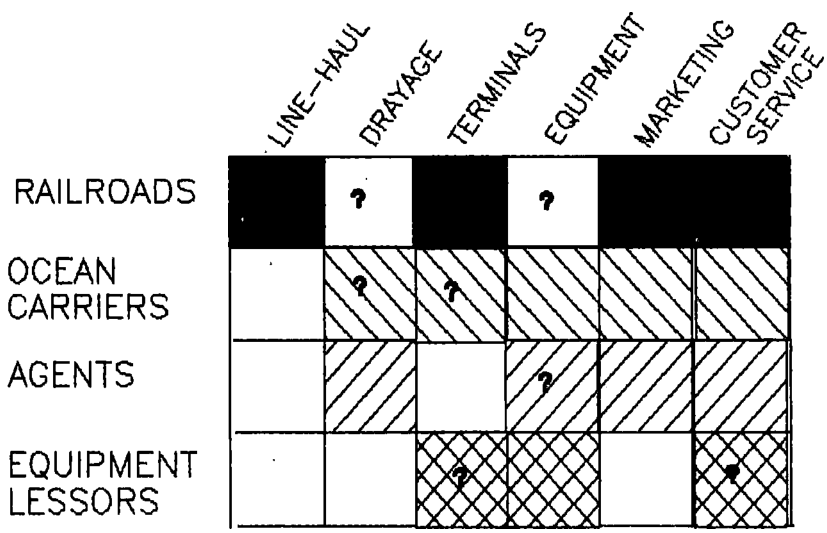
- o Third parties and ocean carrier affiliates market "retail" to actual shippers (beneficial owners) and receivers.

Despite a few retail marketing efforts by the railroads, this pattern is expected to continue. Domestic affiliates of ocean carriers (such as American President Intermodal or Rail-Bridge) have become a major new force in domestic third-party marketing.

The provision of intermodal equipment has increasingly become the domain of ocean carriers, Trailer Train, and leasing companies. The majority of



1980 - Static Roles



1989 - Changing Roles

Figure 18
Changing Intermodal Roles

domestic container movements (about two-thirds, by some estimates) use ISO containers supplied by ocean carriers or leasing companies, who also supply most domestic containers. Although APL and Sea-Land purchased some cars early in the double-stack era, and some railroads have acquired cars since the ICC decision prohibiting Trailer Train car assignments, Trailer Train has supplied and will most likely continue to supply the majority of the double-stack car fleet. Chassis are supplied by ocean carriers or, increasingly, by leasing companies who operate neutral chassis pools at major intermodal hubs. Terminal lift equipment can be leased or supplied by contract terminal operators. Even locomotives are commonly leased, or provided on "power by the hour" or "power by the mile" arrangements. It is possible for a railroad to operate double-stack trains without acquiring any equipment at all.

Railroads own most inland terminals, but they no longer operate all of them. Many are operated under contract by subsidiaries or independent firms. Some ocean carrier subsidiaries have opened their own inland terminals, as have some major shippers and third parties.

Drayage is most often performed by local firms that range from independent owner-operators to sizable trucking companies. Some drayage is provided by railroad or multimodal subsidiaries. Because drayage cost and service is such a critical part of door-to-door service, the future will see greater direct involvement in drayage by major intermodal firms -- including railroads -- either directly or through contractual arrangements.

One crucial question remains: Who will take responsibility for organizing the complete door-to-door service for the customer, and for maintaining operating efficiency and service quality? In theory, any one of the major participants could become the manager. In practice, this function has been performed by third parties, including shipper associations, shippers' agents, freight forwarders, brokers, and the domestic affiliates of ocean carriers. The key means of organization is the contract, made possible by deregulation, covering rail services and rates, equipment supply, drayage, and other critical factors. Contracts can bind together traditional and non-traditional participants in any of several configurations to provide an efficient, high-quality service. Although several leading participants have taken steps in this direction it remains to be seen how the various firms will be linked and which firms will emerge as the managers.

B. Multimodal Ownership or Control

One means of organizing and managing a door-to-door double-stack service is to bring some or all of the functions under the ownership or control of one "multimodal" firm. There are numerous approaches to multimodal ownership or control, some of which include functions outside the intermodal field. Indeed, ownership of assets or operations in more than one mode does not necessarily yield integral intermodal transportation. The goal of multimodal firms engaged in intermodal transportation is improved service coordination, better asset utilization, and the sometimes elusive synergy of marketing and operations in related fields.

The best known multimodals active in double-stack service are American President Companies (APC) and CSX Corp. APC includes American President Lines (an ocean carrier), American President Intermodal (which manages double-stack operations), American President Distribution Services (formerly National Piggyback, a major third party), and American President Trucking, among others, and provides Red Eagle door-to-door service. CSX Corp. includes CSX Transportation (the railroad properties), Sea-Land Service (an ocean carrier), CSX/Sea-Land Intermodal (CSL, operator and marketer of CSX's intermodal services), CMX (a trucking and drayage subsidiary), and others. CSL provides intermodal services extending beyond the CSXT rail network. Several other multimodal firms are active in intermodal transportation. NYK (including Centennial Express and GST Corp.), "K" Line (affiliated with Kerr Steamship, including Rail-Bridge and Rail-Bridge Terminal Corp.) are two examples.

C. Operational Issues

Double-stack services have been thoroughly integrated into rail operations, but several operating issues must be resolved before railroads can offer the service quality required to achieve the full potential of double-stack services.

Single-line service, or its operational equivalent, is imperative. Domestic customers will not switch from trucks if they must endure the delays, and most of all the unreliability, of ordinary rail or "rubber-tired" interchanges. Cost is also an issue, but secondary to the difficulty of obtaining consistent service quality when containers are re-handled and trucked between intermodal yards, or when double-stack cars miss connections or are circuitously routed in the process of interchange.

Stem and dwell time (drayage and waiting at terminals) accounts for substantial costs and substantial delays that truckload carriers do without. More efficient and reliable drayage operations are limited by highway access; the use of heavy retired road tractors instead of lightweight drayage tractors; time-consuming terminal and documentation procedures; and fragmentation of responsibility. As Figure 13 suggests, more efficient drayage could allow double-stack operators to reach out to new markets.

Chassis logistics, container supply, and car supply will not be significant obstacles. Neutral chassis pools are now common, and their use has mitigated many of the chassis problems. Domestic containers are increasingly available from leasing companies, multimodals, and even railroads. Although restrictions attached to Trailer Train's renewed anti-trust immunity may require some readjustment, double-stack cars are being supplied through Trailer Train, ocean carrier affiliates, railroads, and Greenbrier Intermodal.

Overall, however, there is still a large gap between what is possible in double-stack operations and what is now being reliably achieved. Double-stack operations have improved on piggyback operations in transit time, schedule reliability, and damage prevention. Voluntary Coordination Agreements and strategic alliances hold some potential for improved operations. Double-stack operations still fall short of the standard set by truckload carriers, however, and are handicapped by negative shipper perceptions of overall rail service quality and the prior performance record of piggyback.

D. Managerial, Marketing, and Institutional Changes

The future of double-stack container services depends on much more than technology and cost comparisons. The greatest challenges to the railroad industry, and to the other participants in double-stack services, are not likely to be technical or economic, but managerial and institutional.

The biggest shortcoming in current double-stack and other intermodal operations is the lack of sensitivity to market needs, particularly in door-to-door reliability. The lack of reliability is one symptom of fragmentation, which handicaps all of the intermodal participants in trying to maintain an efficient, high-quality door-to-door service. Double-stack transportation has developed despite fragmentation, yet it cannot attain its ultimate potential unless the necessary functions are successfully integrated in the eyes of the customer.

The variety of intermodal participants and the numerous ways in which they can be linked imply a more complex management challenge than is faced by truckload carriers or other single-firm modes. It seems clear that investments in managers and management systems will be necessary to obtain the performance of which the intermodal industry is capable.

The historical intermodal organization of railroads may have been a handicap in the development of reliable, high-quality intermodal services. Most major railroads are now giving intermodal business special status, grouping intermodal functions together as a division, profit center, business unit, or subsidiary. Examples include CNW's Global One Transportation, CSL Intermodal, and BN America. Increasing reliability requires sustained management commitment and cooperation within and without. To address the issues of intermodal marketing and service quality, however, such business units may need more autonomous decision-making authority. Yet decentralizing authority may be difficult in an industry that has used modern communications and information systems to centralize decision-making in other areas. The creation of a strong, responsive intermodal business unit may also require additional personnel (at a time when most railroads have offered buyouts and used other means to reduce staff), investment in management systems, and acceptance of start-up losses.

Institutional and organizational changes have extended beyond the railroads. Other intermodal participants--ocean carriers, leasing companies, trucking companies--are also segregating their intermodal functions as business units or subsidiaries. Intermodal transportation, with double-stack service as its most prominent product, is becoming an industry within an industry. As illustrated in Figure 19, the "intermodal industry" is emerging as a linked network of divisions, business groups, and subsidiaries of firms with other transportation interests. Multimodals are emerging as multi-function service providers to other firms, and to each other. Intermodal business groups may have more in common, and more need to work with other intermodal business groups on a daily basis, than with their parent firms.

The emergence of a loosely defined yet discernible intermodal industry may facilitate one promising means of addressing fragmentation short of complete multimodal ownership: the formation of "strategic alliances." For example, the relationship between API and Union Pacific can be termed a strategic alliance: API relies on UP to operate its trains, and UP, in return, relies on API for much of its domestic intermodal sales and marketing. The major reason for forming strategic alliances is to offer the same "seamless" door-to-door service that multimodals are trying to achieve. Strategic alliances will likely function as less formal, and less risky alternatives to multimodal ownership or control. Strategic alliances may also extend the reach of multimodal organizations in ways that would otherwise be legally or financially difficult.

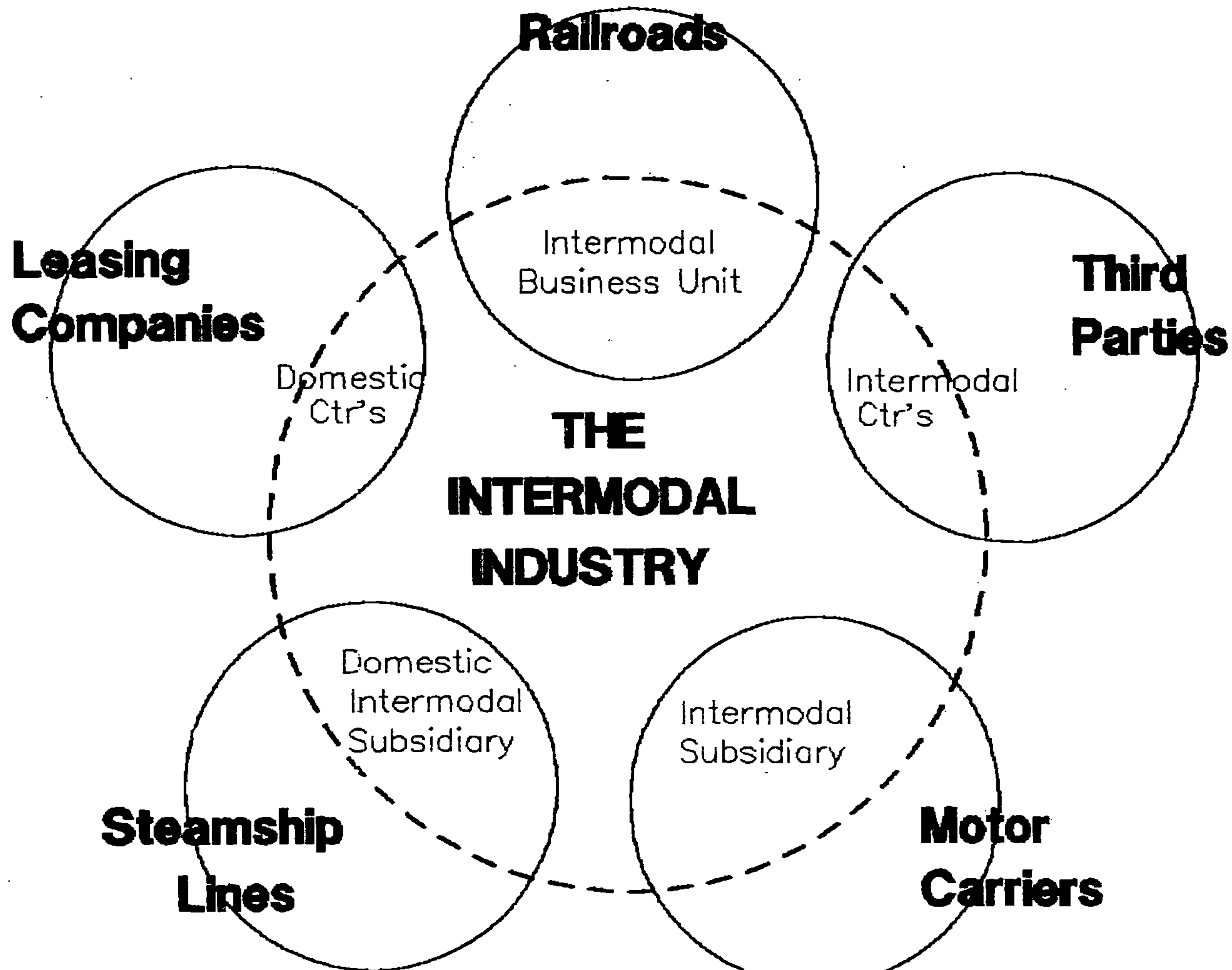


Figure 19

The Emerging Intermodal Industry

VI. IMPLICATIONS FOR PORTS AND OCEAN CARRIERS

A. Implications for Ports

The expansion of double-stack services has increased inter-regional and intra-regional port competition for discretionary international container movements, and extended historic hinterlands. Previously, ports competed with other nearby ports for traffic in regional hinterlands. With expanded double-stack service, containers can take many routes to the same inland point, bringing ports in different regions into fierce competition.

There will be a more active port role in promotion of rail access and rail container transfer facilities. To maximize the potential benefits to its clients and to improve its competitive position, each container port will be encouraged to seek efficient direct access by multiple railroads and to provide on-dock or near-dock rail transfer facilities. Besides being technically and financially difficult, these objectives may bring ports into conflict with railroads or ocean carriers that already enjoy competitive advantages from good access or transfer capabilities. Each port, port city, and railroad will have to arrive at its own solution.

There will be reduced need for "port trains" or port marketing of double-stack services as railroads, third parties, and ocean carrier subsidiaries perform those functions more effectively. At the outset of double-stack service, several ports proposed direct involvement as a means of securing double-stack benefits for smaller ocean carriers. The widespread availability of "common user" trains and the remarketing of excess intermodal capacity by affiliates of larger ocean carriers has largely eliminated any need for direct port involvement.

Ports may face serious impediments to development of desirable intermodal facilities. The supply of land in major container ports is severely limited, and subject to competing demands for marine terminal use or real estate development that may appear more lucrative than intermodal use. The supply of port funds is also limited, and the same growth that leads a port to consider investing in rail transfer facilities or tunnel clearances also demands expenditures for marine terminals, container cranes, and other traditional port activities. Finally, approval processes for any kind of port development are becoming lengthy and expensive.

Further expansion of double-stack services may encourage a shift of transatlantic cargo. A substantial part of the transatlantic cargo, especially European imports, still moves in all-water service via the Panama Canal. Because MLB service developed first in the Asian trades, that cargo has already shifted, leaving European imports for the West Coast as the major all-water movement. A shift in that cargo may come through increased cooperation of Atlantic carriers and Atlantic ports with transpacific carriers for rail movement of European containers on transcontinental double-stack trains.

There has been considerable concern within the port community that a major influx of domestic containers could congest port, or port-area, facilities. This concern appears to be unfounded. First, the major near-term source of domestic container traffic is likely to be domestic trailer traffic, and the conversion will not increase throughput pressures at existing facilities. Second, most major rail hubs, including port cities, appear to have reserve capacity, and those that require near-term expansion are already being expanded. Third, and perhaps most critically, all of the parties involved--shippers, third parties, ocean carriers, railroads, and ports--have incentives to keep domestic containers out of congested ports and port area facilities. Allowing domestic containers to enter busy port facilities would incur extra costs for handling and drayage, as well as delaying the movement and hampering marine operations. A small amount of domestic container traffic now enters port facilities apparently as a short-term expedient where there is adequate terminal capacity. Domestic services that involve such routing are not likely to be fully competitive in the long run.

B. Implications for Ocean Carriers

As the double-stack network expands, improvements in service frequency and market access will broaden and intensify the competition among ocean carriers. The availability of third-party and common-user services to more inland hubs will be of particular value to smaller carriers, and will enable larger carriers to serve secondary markets in which they have only a small volume of traffic.

The increased ocean carrier competition and emphasis on service quality will tend to concentrate international container traffic in the hands of large intermodal carriers, who can control door-to-door service across the country. Provision of high-quality door-to-door service requires substantial financial resources and a large revenue base, both of which are likely to be beyond the reach of medium-sized carriers. The international intermodal market thus will tend to bifurcate into large intermodal carriers and small carriers who use the services of others, with little middle ground.

The 40-foot or 45-foot ISO marine container will face a serious challenge from the 48-foot domestic container in domestic markets. The domestic box offers 13 percent more cubic capacity than a 45-foot box, and 28 percent more than a 40-foot box and greater weight capacity as well. As domestic containers become more prevalent, ocean carriers will have to either offer discounts or market ISO boxes selectively to customers who can use or tolerate smaller boxes.

The problem of overweight containers is likely to affect ocean carriers more than it will affect railroads or ports. Ocean carriers or their domestic affiliates are generally the parties who accept loaded containers from the actual shippers. With regulatory and legislative efforts to narrow responsibility for overweight containers now being considered, ocean carriers may find an enforcement role thrust on them.

Shippers and third parties are wooed by numerous ocean carriers, intermodal subsidiaries, and railroads, all seeking backhaul freight. The former backhaul discount has become the market price, and there have been instances of excess double-stack fleet capacity. Should such excess capacity develop and persist, those ocean carriers who own cars or have them on long-term lease, chiefly APL and Sea-Land, would be directly affected. Other carriers, however, would be indirectly affected to the extent that excess capacity drives the backhaul revenues still lower.

The North American subsidiaries and affiliates of major ocean carriers are likely to maintain their major role in domestic containerization, while the ocean carriers themselves concentrate on international movements. The growing volume of domestic business has led numerous ocean carriers to establish subsidiaries or affiliates with separate management structures and profit centers. Those that contract for double-stack service and let third parties market the service will only be passive providers of containers, however large the volume. Those that take a more direct role in operating and marketing double-stack services are more likely to enter the ranks of multimodals.

VII. MARKET FORCES AND THE DOUBLE-STACK NETWORK

A. Market Forces and Incentives

All the findings of this study indicate that market forces presently at work will bring about an effective double-stack network for domestic and international container traffic. Double-stack container systems offer a more efficient, competitive, and potentially profitable means of carrying large volumes of trailer and boxcar traffic that might otherwise shift to truck. There is an even larger body of traffic potentially divertible from trucks if the double-stack system can attain its full potential. Operational, marketing, and institutional obstacles identified in this study must be overcome for railroads and other parties to realize the full potential of double-stack container systems. Until railroads, third parties, and other intermodal operators do so, they will continue to compete on price, and remain highly vulnerable to truckload competition. Sufficient incentives exist, however, for the emerging intermodal industry to form partnerships or strategic alliances in pursuit of efficient, high-quality, door-to-door service.

B. The Extent of Double-Stack Conversion

Competition for Existing Rail Traffic. The relevant rail traffic discussed earlier includes all container and trailer traffic, and a large volume of selected boxcar traffic, under the assumption that all such traffic could be carried efficiently in double-stacked containers. Regardless of whether this conversion is technically possible in every case, there are commercial and economic reasons why double-stack services will have to compete actively for existing rail traffic, and reasons why some existing rail traffic may not be converted.

Container traffic will remain on other intermodal cars (flatcars or spine cars) where:

- o line clearances are insufficient for double-stacks;

- low or sporadic volumes prevent the efficient use of double-stack cars; or

- individual containers are shipped on chassis, and are treated as trailers.

Most major corridors already have, or will shortly have, adequate clearances. Spine cars are envisioned as a means of providing efficient interim service where clearances will eventually be improved, or in the smallest markets where double-stack utilization would be prohibitively poor. Because single double-stack cars can be added to conventional trains, however, there will be few markets that are large enough for regular intermodal service yet too small for any double-stack service. A very few containers still move on chassis, because, for example, they are moving to a facility that does not yet have mechanical lift equipment.

There is a substantial body of rail trailer traffic that will not convert immediately or easily to containers. Much of this trailer traffic is accounted for by United Parcel Service, the U.S. Postal Service, and major less-than-truckload (LTL) motor carriers. These customers have large-scale operations built around trailers, often 28-foot "pups" that can be hauled in tandem or even triples over the highway. UPS and the Postal Service have tested domestic containers to some extent between Chicago and Dallas, but the vast majority of their traffic moves by trailer, and will likely remain in trailers for some years to come. Among the major railroads, Conrail, CSX, and Santa Fe expect a substantial body of trailer traffic to remain, and have invested accordingly. Union Pacific, although publicly committed to double-stacks, has announced that trailer service will be available where required by major customers.

Other trailer traffic, specifically the price-sensitive traffic tendered by domestic third-party shippers, is much more likely to convert to double-stacked containers in the near future. Much trailer traffic has already done so. As of late 1989, intermodal trailer traffic was declining at about 1 percent annually, while container traffic was growing at about 6 percent annually, more than can be attributed to 1989 international trade growth. Moreover, the piggyback trailer fleet is declining, although some annual replacements are still considered necessary to maintain an adequate fleet in the declining market.

Double-stack competition for boxcar traffic may be problematical. Although most boxcar commodities can be carried in a container, double-stack container systems may not be able to compete for all boxcar traffic. Reports by the ICC (Effects of the Boxcar Exemption, 1988) and by Railbox (Nationwide Demand for 50-ft Boxcars, 1988) concluded that boxcar transportation thrives in well-established niche markets, such as the movement of pulp and paper from the Pacific Northwest and Southeast. Boxcars can provide transportation of price-sensitive, semi-processed and "unsold" goods at very low cost, and at locations with poor highway access or far from the nearest intermodal hub with low backhaul potential. Where boxcar is still an efficient mode, it will be difficult for double-stack services to compete.

Competition with Trucks. Marketplace competition with truckload carriers is more complex than merely determining if the haul is long enough to yield line-haul cost savings for double-stacks. In particular, double-stack service may have to convert both fronthaul and backhaul truck movements, since conversion of only one haul would leave an empty truck searching for a load. The task becomes even more difficult when the truck is repositioned for a substantial distance to reach the backhaul customer. Refrigerated truckload traffic presents a second challenge, since a practical domestic refrigerated double-stack system has yet to be implemented. Some steamship lines have begun to move refrigerated marine containers on double-stacks using demountable generator sets to power the refrigeration units enroute. This approach and other similar approaches hold considerable potential for domestic application.

Despite success in major corridors and between major cities, domestic double-stack services have not yet attracted significant truckload traffic in secondary corridors, or in areas farther from major hubs. To do so, double-stack operators would have to extend the reach of economical and efficient drayage service. It is now feasible to dray for long distances (up to 200 miles, sometimes more) only in the direction of travel. If the cost of drayage could be reduced through the use of more efficient equipment, through improvements in terminal operations, or through long-term contractual commitments, many new markets and much new traffic would become accessible.

As noted earlier, there are numerous tangible and intangible features to service quality, and the service criteria set forth in this report quantify only transit time and service frequency. Thus far, domestic double-stack services have diverted truck traffic in long corridors (1500 miles or more) where international traffic dictates frequent service and low backhaul rates prevail. Although double-stacks out-perform conventional piggyback and could be more competitive with trucks, their acceptance is hindered by a lingering perception of poor rail service quality. To penetrate the truckload market further, domestic double-stack services will need to match or better truckload service on more of the tangible and intangible service features, such as reliability, claims handling, and responsiveness to customer needs. Much progress must be made before double-stack services can be sold to domestic customers without offering a heavy discount relative to truckload rates.

C. Market Shortfalls and Public Sector Involvement

Although market forces are sufficient to create a viable double-stack network, there are some areas in which market forces and private sector initiative may be insufficient to bring about desirable developments. In such cases, public sector involvement might be one option.

There still exist some physical impediments to double-stack service, notably railroad line clearances. The railroads have made substantial progress in improving clearances, and there have been precedents for public involvement in financial assistance to Conrail from the State of Pennsylvania, and to Union Pacific by the Port of Oakland. Clearances elsewhere, however, may pose significant costs that cannot be borne solely within the intermodal industry. There may be substantial public benefits if clearance improvements lead to more efficient port access and reduced port-area congestion.

There are two areas in which the intermodal industry would benefit from the establishment of standards. Although container size is not a major issue, the industry would benefit from an early resolution of the ISO "wide body" 49-foot marine container controversy. The development of an efficient double-stack network would also certainly benefit from wider agreement on standards for Electronic Data Interchange and Automatic Equipment Identification.

Another shortcoming revealed in this study is the shortage of relevant data for public or private planning. Existing public data sources (i.e. the ICC Carload Waybill Sample or the Bureau of the Census import/export data) are incompatible, and were not designed to cope with the complexities of domestic or international intermodal transportation. The only source of current truckload data is the NMTDB, which is available through subscription but was not designed to identify some of the shorter-haul traffic that may become relevant. The intermodal industry, and the ports and other public bodies that may be affected by intermodal traffic, are thus without a source of comprehensive or standardized data.

Intermodal access within urban areas is perhaps the major issue in which resolution is beyond the reach of market forces. Access problems result from, and contribute to, congestion in port areas and in major inland hub cities. Restrictions on truck traffic being considered for the Los Angeles basin would severely hinder international and domestic double-stack operations in Southern California, but that issue involves questions of public policy far beyond the intermodal considerations. At major inland hubs such as Chicago, St. Louis, and New Orleans, large volumes of intermodal traffic are "rubber tired" (drayed between railroads) over local streets and highways: a preliminary estimate by ALK Associates suggests that roughly 1000 trailers per day pass through the streets of Chicago while being interchanged between railroads. The impacts on port cities and inland hub cities have led to proposals for public assistance with road improvements and other access projects beyond the scope of market forces.

VIII. MAJOR CONCLUSIONS

The results of the study confirm the growth potential of domestic double-stack container systems. The results suggest that double-stack services can be fully competitive with trucks in dense traffic corridors of 725 miles or more. In such corridors, there is sufficient rail and truckload traffic to multiply the existing domestic double-stack traffic several times over. Beyond these major corridors, there are further opportunities in secondary corridors, in outlying areas near major hubs, and in refrigerated commodities.

This study identifies several obstacles to achieving that potential. None is insurmountable, but all will require sustained commitment of resources and management attention. Some obstacles are technical, involving the features of double-stack cars and containers, the efficiency and reliability of operations, and the accommodation of new traffic patterns. The more serious obstacles, and those requiring the most immediate attention, tend to involve marketing, management, and organization.

Full realization of the domestic double-stack potential may require railroads to take unaccustomed steps into marketing, sales, and customer service. The alternative is for railroads to become strictly line-haul contract carriers, and rely on third parties or ocean carrier affiliates for marketing, customer service, door-to-door management, and perhaps even terminal operations.

For ports and ocean carriers, the implications are mixed. Ports will be under continuous competitive pressure to accommodate international double-stack growth, but will be only indirectly affected by domestic containerization. Ocean carriers, too, will be subject to competitive pressure, but may find new opportunities in meshing their international container movements with a growing domestic double-stack service.

The advent of double-stack container systems has dramatically altered intermodal transportation. New firms have entered the field, most prominently the ocean carriers and their affiliates. Existing firms have new roles, and have come together in new alliances. A distinct intermodal industry is emerging.

Underlying all of this activity is a belief in the potential growth of domestic and international double-stack services and traffic.

The intermodal industry faces several challenges that can be summed up as one: the industry must provide and market a reliable, high-quality, door-to-door service. That challenge affects the intermodal industry as a whole, because it encompasses technology, line haul operations, terminal operations, marketing, sales, customer service, management, and organization. If the intermodal industry can overcome the obstacles to door-to-door service quality in each of those areas, double-stack container systems can compete successfully with trucks and with other intermodal systems, and sustain a larger market share than intermodal transportation has yet earned.

The study concludes that existing market forces can bring about the development of an efficient double-stack network to serve both domestic and international traffic. There are some areas, notably in line clearances and highway/rail access, where public sector involvement may be helpful. The degree to which double-stack container services attain their potential, however, depends on the ability of the intermodal industry to meet the technical marketing, managerial, and organizational challenges it faces.